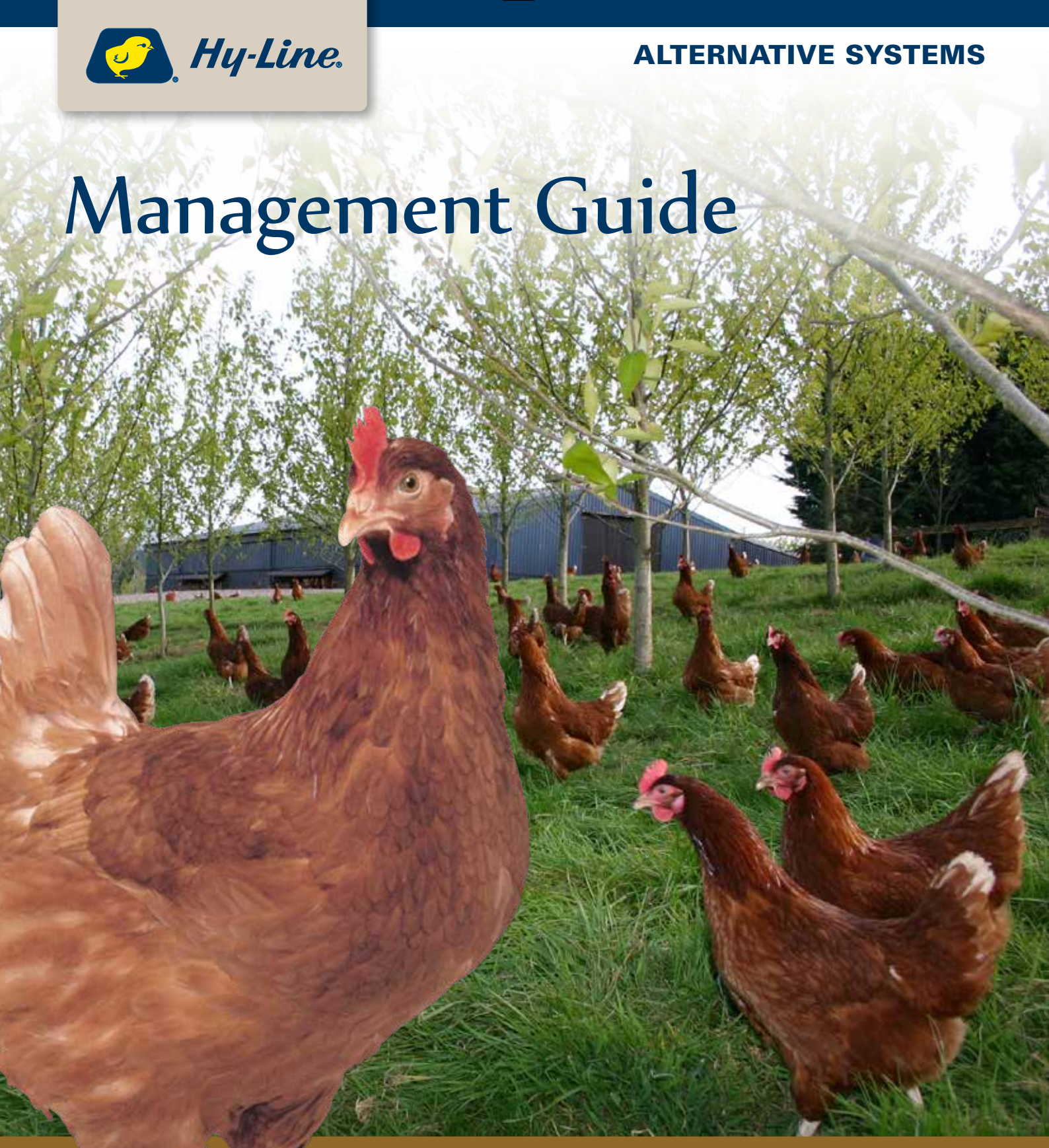
Hy-Line

ALTERNATIVE SYSTEMS

Management Guide



Hy-Line®

BROWN

USE OF THE MANAGEMENT GUIDE

The genetic potential of Hy-Line Brown in alternative systems of housing can only be realized if both good poultry husbandry practices and appropriate management practices are used. This management guide outlines successful flock management programs for Hy-Line Variety Brown based on field experience compiled by Hy-Line International and using an extensive commercial flock database of Hy-Line flocks from all parts of the world. Hy-Line International Management Guides are periodically updated as new performance data and/or nutrition information become available.

The information and suggestions contained in this management guide should be used for guidance and educational purposes only, recognizing that local environmental and disease conditions may vary and a guide cannot cover all possible circumstances. While every attempt has been made to ensure that the information presented is accurate and reliable at the time of publication, Hy-Line International cannot accept responsibility for any errors, omissions or inaccuracies in such information or management suggestions. Further, Hy-Line International does not warrant or make any representations or guarantees regarding the use, validity, accuracy, or reliability of, or flock performance or productivity resulting from the use of, or otherwise respecting, such information or management suggestions. In no event shall Hy-Line International be liable for any special, indirect or consequential damages or special damages whatsoever arising out of or in connection with the use of the information or management suggestions contained in this management guide.

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INTRODUCTION

Management systems which are alternatives to conventional (intensive) layer cages have been developed to satisfy the increasing consumer demand for eggs produced in systems that provide a more enriched bird environment, where natural bird behaviors can be expressed. These production systems require different management to optimize production and bird welfare. Generally, alternative production systems fall into three broad categories:

Barn Systems—Floor systems with a litter area which covers part or all of the house. Birds are allowed to freely move within the house. An elevated slat area with nests, feeders, perches and waterers is provided. Automatic colony nest boxes are utilized for egg collection.

Aviary Systems—Multi-tier structures over a litter floor where nests, feeders, waterers, perches and welfare enrichments are provided. Aviary systems are typically designed to have feeders on some levels, and nests and waterers on other levels. Manure belt disposal systems are provided on elevated levels of the system. The ground floor level is often designed to allow confined brooding of chicks. The litter floor area should be greater than 30% of the usable space in the aviary, including slat floors but excluding the nests and perches. The top level is typically for birds to rest/sleep. Aviaries increase the living space within a house, allowing the placement of more birds.

Free Range Systems—Barn or aviary systems where birds have access to the outside. Outside areas can be pasture areas with perimeter fencing, or summer porches or verandas which are enclosed with fencing and a roof. Some free range systems allow constant access to pasture/range areas and utilize mobile housing units with feed and water, which are periodically moved to keep the pasture fresh.

Aviary systems utilize the vertical space within a house to allow better use of the facility and to provide environmental enrichments to increase bird welfare.

Aviary systems typically have littered scratch areas between rows of multi-level living areas with feeders, waterers, perches and nests.

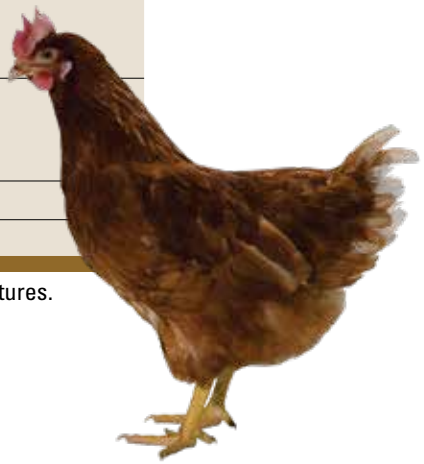
Barn systems allow birds free movement. Floors can be slatted, littered or a combination of both.

Summary of Performance Standards

REARING PERIOD (TO 17 WEEKS):	
Livability	98%
Feed Consumed	6.06–6.43 kg
Body Weight at 17 Weeks	1.40–1.44 kg
LAYING PERIOD (TO 90 WEEKS):	
Percent Peak	95–96%
Hen-Day Eggs to 60 Weeks Hen-Day Eggs to 72 Weeks Hen-Day Eggs to 90 Weeks	257–266 325–336 419–432
Hen-Housed Eggs to 60 Weeks Hen-Housed Eggs to 72 Weeks Hen-Housed Eggs to 90 Weeks	253–262 319–330 408–421
Livability to 60 Weeks Livability to 80 Weeks Livability to 90 Weeks	97% 95% 93%
Days to 50% Production (from hatch)	140 days
Average Egg Weight at 26 Weeks Average Egg Weight at 32 Weeks Average Egg Weight at 72 Weeks	57.3–59.7 g / egg 60.1–62.5 g / egg 63.0–65.6 g / egg
Total Egg Mass per Hen-Housed (18–90 Weeks)	25.5 kg
Body Weight at 32 Weeks Body Weight at 72 Weeks	1.85–1.97 kg 1.91–2.03 kg
Freedom From Egg Inclusions	Excellent
Shell Strength	Excellent
Shell Color Score at 38 Weeks Shell Color Score at 56 Weeks Shell Color Score at 72 Weeks Shell Color Score at 90 Weeks	87 85 81 79
Haugh Units at 38 Weeks Haugh Units at 56 Weeks Haugh Units at 72 Weeks Haugh Units at 90 Weeks	90.0 84.0 81.0 79.7
Average Daily Feed Consumption (18–90 weeks)	105–116 g / day per bird*
Feed Conversion Rate, kg Feed/kg Eggs (20–60 weeks) Feed Conversion Rate, kg Feed/kg Eggs (20–72 weeks) Feed Conversion Rate, kg Feed/kg Eggs (20–90 weeks)	1.96–2.17 2.00–2.20 2.07–2.28
Feed Utilization, kg Egg/kg Feed (20–60 weeks) Feed Utilization, kg Egg/kg Feed (20–72 weeks) Feed Utilization, kg Egg/kg Feed (20–90 weeks)	0.46–0.51 0.45–0.50 0.44–0.48
Feed Consumption per 10 Eggs (20–60 weeks) Feed Consumption per 10 Eggs (20–72 weeks) Feed Consumption per 10 Eggs (20–90 weeks)	1.19–1.26 kg 1.21–1.29 kg 1.26–1.35 kg
Feed Consumption per Dozen Eggs (20–60 weeks) Feed Consumption per Dozen Eggs (20–72 weeks) Feed Consumption per Dozen Eggs (20–90 weeks)	1.42–1.51 kg 1.45–1.55 kg 1.51–1.62 kg
Skin Color	Yellow
Condition of Droppings	Dry

*Actual feed consumption may be higher or lower than this range, depending on environmental temperatures. See table on p. 10 for relationship between feed intake and environmental temperature.

Performance Summary data is based on results obtained from customers around the world. Please send your results to info@hyline.com. An easy to use record-keeping program, ***Hy-Line International EggCel****, can be found at www.hylineeggcel.com.*



Performance Tables

AGE (weeks)		MORTALITY Cumulative (%)	BODY WEIGHT (g)	WATER CONSUMPTION[1] (ml / bird / day)	FEED INTAKE[2] (g / bird / day)	UNIFORMITY
1		0.5	70 – 75	22 – 30	14 – 15	65–70%
2		0.7	110 – 125	27 – 42	17 – 21	
3		0.8	170 – 190	37 – 50	23 – 25	
4		0.9	240 – 270	43 – 58	28 – 30	
5	*Body weight and feed intake ranges are based on a global database. Local conditions will determine your flock results. Consult your local Hy-Line distributor for further information and for results to expect in your area.*	1.0	330 – 360	54 – 72	34 – 36	
6		1.1	420 – 465	61 – 80	38 – 40	
7		1.2	520 – 560	66 – 86	42 – 44	
8		1.3	620 – 670	72 – 94	53 – 57	
9		1.4	730 – 780	78 – 106	55 – 59	
10		1.5	840 – 890	83 – 112	58 – 62	70–75%
11		1.6	940 – 990	93 – 124	62 – 65	
12		1.6	1030 – 1080	99 – 136	65 – 69	
13		1.7	1110 – 1165	107 – 142	69 – 72	
14		1.7	1190 – 1230	112 – 148	74 – 78	80%
15		1.8	1260 – 1300	115 – 152	76 – 80	
16		1.9	1330 – 1370	120 – 158	78 – 82	85%
17		2.0	1400 – 1440	125 – 164	79 – 83	

AGE (weeks)	% HEN-DAY Current	HEN-DAY EGGS Cumulative	HEN-HOUSED EGGS Cumulative	MORTALITY Cumulative (%)	BODY WEIGHT (kg)	WATER CONSUMPTION[1] (ml / bird / day)	FEED INTAKE[1,2] (g / bird / day)	HEN-HOUSED EGG MASS Cumulative (kg)	AVERAGE EGG WEIGHT[3] (g / egg)
18	4 – 14	0.3 – 1.0	0.3 – 1.0	0.0	1.47 – 1.57	131 – 186	82 – 93	0.0	48.8 – 50.0
19	24 – 38	2.0 – 3.6	2.0 – 3.6	0.1	1.57 – 1.67	136 – 192	85 – 96	0.1	49.0 – 51.0
20	45 – 72	5.1 – 8.7	5.1 – 8.7	0.1	1.63 – 1.73	146 – 204	91 – 102	0.3	50.2 – 52.2
21	75 – 86	10.4 – 14.7	10.3 – 14.7	0.2	1.67 – 1.77	152 – 212	95 – 106	0.5	51.5 – 53.6
22	87 – 92	16.5 – 21.1	16.4 – 21.1	0.3	1.72 – 1.82	158 – 220	99 – 110	0.9	53.1 – 55.3
23	92 – 94	22.9 – 27.7	22.8 – 27.7	0.3	1.75 – 1.85	165 – 228	103 – 114	1.2	54.4 – 56.6
24	92 – 95	29.3 – 34.4	29.2 – 34.3	0.4	1.78 – 1.90	168 – 232	105 – 116	1.6	55.5 – 57.7
25	93 – 95	35.8 – 41.0	35.7 – 40.9	0.4	1.79 – 1.91	170 – 234	106 – 117	2.0	56.6 – 59.0
26	94 – 96	42.4 – 47.7	42.3 – 47.6	0.5	1.80 – 1.92	171 – 236	107 – 118	2.3	57.3 – 59.7
27	95 – 96	49.1 – 54.5	48.9 – 54.3	0.6	1.82 – 1.94	171 – 236	107 – 118	2.7	58.4 – 60.8
28	95 – 96	55.7 – 61.2	55.5 – 60.9	0.6	1.83 – 1.95	171 – 236	107 – 118	3.1	59.0 – 61.4
29	95 – 96	62.4 – 67.9	62.1 – 67.6	0.7	1.84 – 1.96	171 – 236	107 – 118	3.5	59.3 – 61.7
30	94 – 96	69.0 – 74.6	68.6 – 74.3	0.7	1.84 – 1.96	171 – 236	107 – 118	3.9	59.7 – 62.1
31	94 – 96	75.5 – 81.3	75.1 – 80.9	0.8	1.84 – 1.96	173 – 238	108 – 119	4.3	59.9 – 62.3
32	94 – 95	82.1 – 88.0	81.7 – 87.5	0.9	1.85 – 1.97	173 – 238	108 – 119	4.7	60.1 – 62.5
33	94 – 95	88.7 – 94.6	88.2 – 94.1	0.9	1.85 – 1.97	173 – 238	108 – 119	5.1	60.3 – 62.7
34	94 – 95	95.3 – 101.3	94.7 – 100.7	1.0	1.85 – 1.97	173 – 238	108 – 119	5.5	60.5 – 62.9
35	94 – 95	101.9 – 107.9	101.2 – 107.3	1.0	1.85 – 1.97	173 – 238	108 – 119	5.9	60.6 – 63.0
36	93 – 94	108.4 – 114.5	107.6 – 113.8	1.1	1.86 – 1.98	173 – 238	108 – 119	6.3	60.7 – 63.1
37	93 – 94	114.9 – 121.1	114.1 – 120.3	1.2	1.86 – 1.98	173 – 238	108 – 119	6.7	60.8 – 63.2
38	93 – 94	121.4 – 127.7	120.5 – 126.8	1.2	1.86 – 1.98	173 – 238	108 – 119	7.1	60.9 – 63.3
39	92 – 93	127.8 – 134.2	126.9 – 133.2	1.3	1.87 – 1.99	173 – 238	108 – 119	7.5	61.0 – 63.4
40	92 – 93	134.3 – 140.7	133.2 – 139.6	1.4	1.87 – 1.99	173 – 238	108 – 119	7.9	61.1 – 63.5
41	91 – 93	140.6 – 147.2	139.5 – 146.0	1.4	1.87 – 1.99	173 – 238	108 – 119	8.3	61.2 – 63.6
42	91 – 92	147.0 – 153.7	145.8 – 152.4	1.5	1.88 – 2.00	173 – 238	108 – 119	8.7	61.3 – 63.9
43	90 – 92	153.3 – 160.1	152.0 – 158.7	1.6	1.88 – 2.00	173 – 238	108 – 119	9.1	61.5 – 64.1
44	90 – 92	159.6 – 166.5	158.1 – 165.0	1.6	1.88 – 2.00	173 – 238	108 – 119	9.5	61.6 – 64.2
45	89 – 91	165.8 – 172.9	164.3 – 171.3	1.7	1.89 – 2.01	171 – 236	107 – 118	9.9	61.6 – 64.2

[1] The chart shows an expected range of waterand feed consumption at normal environmental temperatures of 21–27°C. As the environmental temperature increases above this range, water consumption may increase up to double the amounts shown.

[2] Compared to intensive systems, the feed intake in barn, aviary and free range flocks is generally higher to cover the increased energy demand of more active birds and temperature fluctuations. See table on p. 10 for the approximate relationship between feed intake and environmental temperature.

[3] Egg weights after 40 weeks of age assume phase feeding of protein to limit egg size.

Performance Tables *(continued)*

AGE (weeks)	% HEN-DAY Current	HEN-DAY EGGS Cumulative	HEN-HOUSED EGGS Cumulative	MORTALITY Cumulative (%)	BODY WEIGHT (kg)	WATER CONSUMPTION[1] (ml / bird / day)	FEED INTAKE[1,2] (g / bird / day)	HEN-HOUSED EGG MASS Cumulative (kg)	AVERAGE EGG WEIGHT[3] (g / egg)
46	89 – 91	172.1 – 179.3	170.4 – 177.6	1.8	1.89 – 2.01	171 – 236	107 – 118	10.3	61.7 – 64.3
47	88 – 90	178.2 – 185.6	176.4 – 183.7	1.9	1.89 – 2.01	171 – 236	107 – 118	10.6	61.8 – 64.4
48	88 – 90	184.4 – 191.9	182.5 – 189.9	1.9	1.89 – 2.01	171 – 236	107 – 118	11.0	61.9 – 64.5
49	88 – 90	190.5 – 198.2	188.5 – 196.1	2.0	1.89 – 2.01	171 – 236	107 – 118	11.4	62.0 – 64.6
50	88 – 89	196.7 – 204.4	194.5 – 202.2	2.1	1.89 – 2.01	171 – 236	107 – 118	11.8	62.1 – 64.7
51	87 – 89	202.8 – 210.6	200.5 – 208.3	2.1	1.89 – 2.01	170 – 234	106 – 117	12.2	62.1 – 64.7
52	87 – 89	208.9 – 216.9	206.4 – 214.4	2.2	1.89 – 2.01	170 – 234	106 – 117	12.5	62.2 – 64.8
53	87 – 88	215.0 – 223.0	212.4 – 220.4	2.3	1.89 – 2.01	170 – 234	106 – 117	12.9	62.2 – 64.8
54	87 – 88	221.1 – 229.2	218.3 – 226.4	2.3	1.89 – 2.01	170 – 234	106 – 117	13.3	62.2 – 64.8
55	86 – 88	227.1 – 235.3	224.2 – 232.4	2.4	1.90 – 2.02	170 – 234	106 – 117	13.7	62.2 – 64.8
56	86 – 87	233.1 – 241.4	230.1 – 238.4	2.5	1.90 – 2.02	170 – 234	106 – 117	14.0	62.3 – 64.9
57	85 – 87	239.1 – 247.5	235.9 – 244.3	2.6	1.90 – 2.02	170 – 234	106 – 117	14.4	62.3 – 64.9
58	85 – 87	245.0 – 253.6	241.7 – 250.2	2.6	1.90 – 2.02	170 – 234	106 – 117	14.8	62.3 – 64.9
59	85 – 87	251.0 – 259.7	247.5 – 256.1	2.7	1.90 – 2.02	170 – 234	106 – 117	15.1	62.4 – 65.0
60	84 – 86	256.8 – 265.7	253.2 – 262.0	2.8	1.90 – 2.02	170 – 234	106 – 117	15.5	62.4 – 65.0
61	84 – 86	262.7 – 271.7	258.9 – 267.8	2.9	1.90 – 2.02	170 – 234	106 – 117	15.9	62.5 – 65.1
62	83 – 86	268.5 – 277.8	264.5 – 273.7	2.9	1.90 – 2.02	170 – 234	106 – 117	16.2	62.5 – 65.1
63	83 – 85	274.3 – 283.7	270.1 – 279.4	3.0	1.90 – 2.02	170 – 234	106 – 117	16.6	62.6 – 65.2
64	83 – 85	280.1 – 289.7	275.8 – 285.2	3.1	1.90 – 2.02	170 – 234	106 – 117	16.9	62.6 – 65.2
65	83 – 85	286.0 – 295.6	281.4 – 291.0	3.2	1.90 – 2.02	170 – 234	106 – 117	17.3	62.7 – 65.3
66	82 – 84	291.7 – 301.5	286.9 – 296.6	3.3	1.90 – 2.02	170 – 234	106 – 117	17.7	62.7 – 65.3
67	81 – 84	297.4 – 307.4	292.4 – 302.3	3.4	1.90 – 2.02	170 – 234	106 – 117	18.0	62.8 – 65.4
68	81 – 83	303.0 – 313.2	297.9 – 307.9	3.5	1.90 – 2.02	170 – 234	106 – 117	18.4	62.8 – 65.4
69	81 – 82	308.7 – 318.9	303.3 – 313.4	3.7	1.90 – 2.02	170 – 234	106 – 117	18.7	62.9 – 65.5
70	80 – 82	314.3 – 324.7	308.7 – 319.0	3.8	1.91 – 2.03	170 – 234	106 – 117	19.1	62.9 – 65.5
71	79 – 81	319.8 – 330.3	314.0 – 324.4	3.9	1.91 – 2.03	170 – 234	106 – 117	19.4	63.0 – 65.6
72	79 – 81	325.4 – 336.0	319.3 – 329.9	4.0	1.91 – 2.03	170 – 234	106 – 117	19.7	63.0 – 65.6
73	78 – 80	330.8 – 341.6	324.6 – 335.2	4.1	1.91 – 2.03	170 – 234	106 – 117	20.1	63.1 – 65.7
74	77 – 80	336.2 – 347.2	329.7 – 340.6	4.3	1.91 – 2.03	170 – 234	106 – 117	20.4	63.1 – 65.7
75	76 – 79	341.5 – 352.7	334.8 – 345.9	4.4	1.91 – 2.03	170 – 234	106 – 117	20.7	63.2 – 65.8
76	76 – 78	346.9 – 358.2	339.9 – 351.1	4.5	1.91 – 2.03	170 – 234	106 – 117	21.1	63.2 – 65.8
77	75 – 77	352.1 – 363.6	344.9 – 356.2	4.7	1.91 – 2.03	170 – 234	106 – 117	21.4	63.3 – 65.9
78	75 – 77	357.4 – 369.0	349.9 – 361.3	4.8	1.91 – 2.03	170 – 234	106 – 117	21.7	63.3 – 65.9
79	74 – 77	362.5 – 374.4	354.8 – 366.5	5.0	1.91 – 2.03	170 – 234	106 – 117	22.0	63.4 – 66.0
80	74 – 76	367.7 – 379.7	359.7 – 371.5	5.1	1.91 – 2.03	170 – 234	106 – 117	22.4	63.5 – 66.1
81	74 – 76	372.9 – 385.0	364.6 – 376.5	5.3	1.91 – 2.03	170 – 234	106 – 117	22.7	63.5 – 66.1
82	74 – 76	378.1 – 390.3	369.5 – 381.6	5.4	1.91 – 2.03	170 – 234	106 – 117	23.0	63.5 – 66.1
83	73 – 75	383.2 – 395.6	374.4 – 386.5	5.6	1.91 – 2.03	170 – 234	106 – 117	23.3	63.6 – 66.2
84	73 – 75	388.3 – 400.8	379.2 – 391.5	5.7	1.91 – 2.03	170 – 234	106 – 117	23.6	63.6 – 66.2
85	73 – 75	393.4 – 406.1	384.0 – 396.4	5.9	1.91 – 2.03	170 – 234	106 – 117	23.9	63.6 – 66.2
86	73 – 75	398.5 – 411.3	388.8 – 401.4	6.0	1.91 – 2.03	170 – 234	106 – 117	24.2	63.6 – 66.2
87	72 – 74	403.6 – 416.5	393.5 – 406.2	6.2	1.91 – 2.03	170 – 234	106 – 117	24.5	63.7 – 66.3
88	72 – 74	408.6 – 421.7	398.2 – 411.1	6.3	1.91 – 2.03	170 – 234	106 – 117	24.9	63.7 – 66.3
89	72 – 74	413.6 – 426.9	402.9 – 415.9	6.5	1.91 – 2.03	170 – 234	106 – 117	25.2	63.7 – 66.3
90	72 – 74	418.7 – 432.0	407.7 – 420.7	6.6	1.91 – 2.03	170 – 234	106 – 117	25.5	63.7 – 66.3

[1] The chart shows an expected range of water and feed consumption at normal environmental temperatures of 21–27°C. As the environmental temperature increases above this range, water consumption may increase up to double the amounts shown.

[2] Compared to intensive systems, the feed intake in barn, aviary and free range flocks is generally higher to cover the increased energy demand of more active birds and temperature fluctuations. See table on p. 10 for the approximate relationship between feed intake and environmental temperature.

[3] Egg weights after 40 weeks of age assume phase feeding of protein to limit egg size.

Chick Management

Hy-Line Brown chicks adapt well to both floor and aviary system brooding environments. Hatchery services/treatments are performed as requested by the customer. For more information, see the "Growing Management of Commercial Pullets" technical update at www.hyline.com.

General Recommendations

HOUSE PREPARATIONS

- Clean and disinfect brooding areas, building interior, attached service areas and equipment.
- Check to make sure equipment is working properly and is adjusted to the correct height.
- Remove all old feed from bins, hoppers and troughs.
- Clean and disinfect feeding system, allowing it to dry before new feed is delivered.
- Place rodent bait where it will not be consumed by chicks.

ONE DAY BEFORE DELIVERY

- Set the brooder thermostat to 35–36°C at chick level.
- Check water system and adjust to the correct height for chicks. Sanitize and flush water lines.

ON THE DAY OF DELIVERY

- Check that house temperatures are appropriate for brooding chicks.
- As chicks are placed, trigger water cups or nipples to encourage drinking.
- When using nipple drinkers, adjust the water pressure to ensure there is a droplet of water visible on the nipple.
- Place supplementary feed onto papers or trays.
- Adjust feeders to their highest feed level, allowing easy access for the chicks.
- Lights should be adjusted to provide a minimum light intensity of 30 lux for the first week.
- Brood chicks in groups of similiar aged breeder flocks.

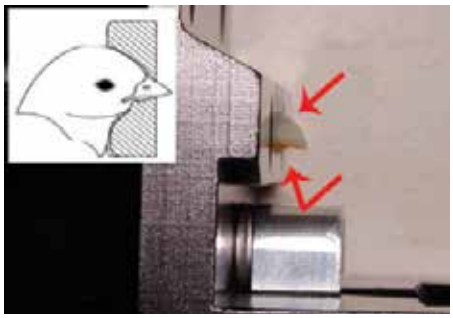
Infrared Beak Treatment (IRBT)

(Check local regulations concerning use of beak treatment)

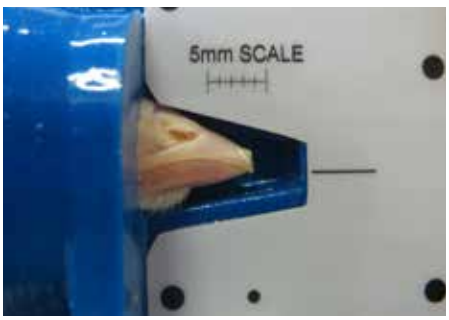
- Infrared beak treatment has been proven a successful, non-invasive method of controlling the growth of the beak in egg type chickens.
- One properly applied IRBT should be sufficient.
- Hatchery beak treatment reduces feed wastage and leaves the beak less damaging to other birds.
- Hatchery beak treatment is efficient and uniform.
- Beak remains intact until 10–21 days of age, when the treated beak tip will soften and slough off gradually.
- Infrared treatment is adjustable to manage differences in breeder flock age, chick size and variety of birds.
- For more information, see the "Infrared Beak Treatment" technical update at www.hyline.com.

Precautions when performing beak treatment:

- Water intake is the most important factor for success with IRBT chicks. Chicks require immediate and easy access to water.
- Use only 360° activated nipples for IRBT chicks, as well as supplemental chick drinkers.
- Nipple drinkers with splash cups provide additional support for IRBT chicks.
- Keep feed at the highest level for several days after beak treatment.
- Feed on paper for 0–7 days.
- Provide extra light on nipple drinkers after beak treatment.



Infrared beak treatment can be modified according to local conditions.



Immediately following infrared beak treatment on day of hatch

7 days after infrared beak treatment

Brooding Recommendations

The brooding period (0–14 days) of the pullet's life is critical. Good management during this period can assure that the pullet gets off to a good start toward reaching her genetic potential.

RING AND PARTIAL HOUSE BROODING SYSTEMS

Water

- Drinking water should be tested for quality and cleanliness from source and end of the water line.
- Flush water lines prior to chick arrival.
- Do not give cold water to chicks. Be careful when flushing water lines for chicks. Allow water time to warm up in the house so chicks are comfortable drinking.
- Flush water lines at night to limit chicks' exposure to cold drinking water.
- Maintain water temperature of 20–25°C during brooding period.
- Clean supplemental chick drinkers daily to avoid build-up of organic matter that could encourage bacterial growth.
- Use a ratio of 80 chicks / circular drinker (25 cm diameter).
- Chicks should not have to move more than 1 meter to find water.
- Use vitamins and electrolytes in chicks' drinking water (avoid sugar-based products to prevent growth of microorganisms).

Paper

- Cover entire floor of brooder ring with paper. In partial house brooding, feed off of paper placed close to the permanent feeders.
- Place starter feed on paper for 0–3 days. For beak-treated chicks, feed on paper for 0–7 days.
- Remove paper between 7–14 days to avoid the buildup of manure.
- Litter should not be more than 5 cm deep.

Lights

- Bright light (30–50 lux) during 0–7 days helps chicks find feed and water and adapt to the house environment.

Tray feeders

- Use a ratio of 80 chicks / tray feeder. Clean egg trays and box tops can also be used.
- Use good quality crumble starter feed consisting of uniform 1–2 mm particles.

Partial House (Floor) Brooding

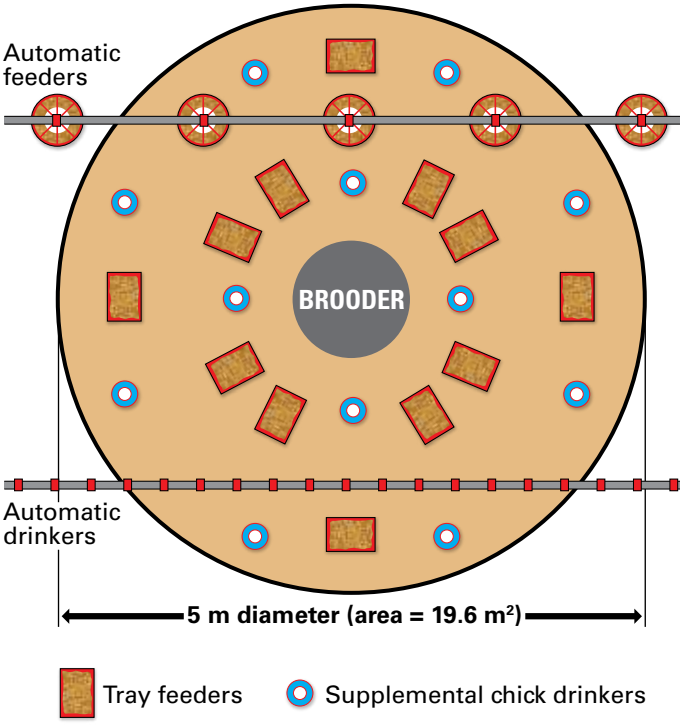
- A section of the house is partitioned and used for brooding.
- Twenty-four hours prior to chick delivery, set thermostats placed at chick level at 35–36°C.
- Minimum house air temperature during floor breeding is 30°C.
- Eliminate all drafts from the house.
- Spread litter after concrete floors have warmed.
- Gradually remove supplemental drinkers and tray feeders beginning at 3 days.

Brooder Rings

- Enlarge brooder rings at 3 days to increase group size.
- Continue enlarging brooder rings until rings are removed by 14 days.
- Gradually remove supplemental drinkers and tray feeders beginning at 3 days.

Aviary Systems

- Chicks that are retained within the aviary system during brooding must have access to a littered area.
- Introduce chicks to the entire aviary system as soon as possible. Chicks should have access to raised areas by 15 days of age.

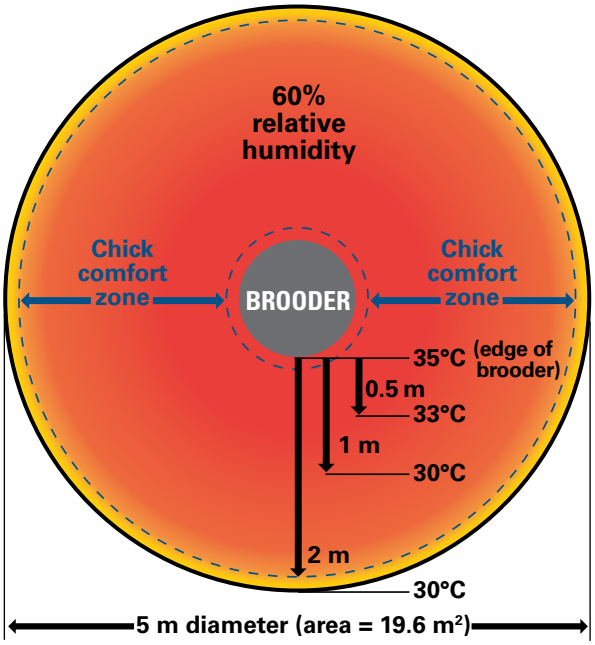


Use ramps to assist birds onto higher levels of the aviary. Flocks that learn at an early age to use the entire system perform best. Photo courtesy Big Dutchman.

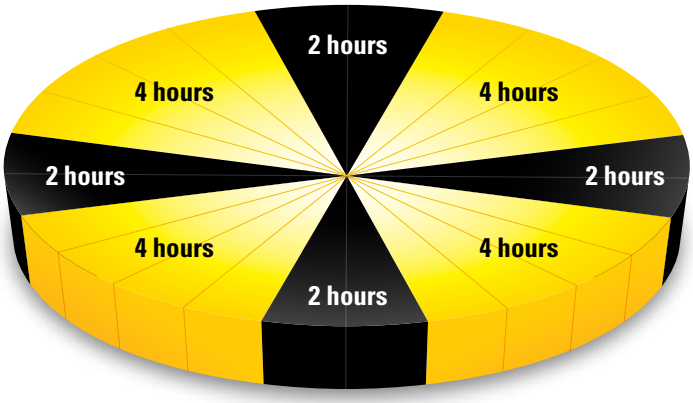
Brooding Recommendations *(continued)*

BROODING TEMPERATURE

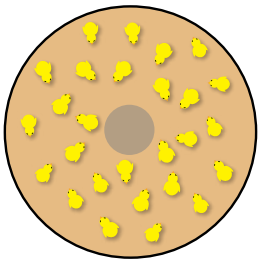
- Find optimum balance of temperature, humidity and ventilation rate for chick comfort.
- Adjust brooder temperatures according to relative humidity. Lower temperatures should be used with higher humidity. For every 5 percentage point increase above 60% relative humidity, reduce brooding temperature 1°C.
- Provide temperature zones within the brooding ring accessible to the chicks. This allows them to seek their comfort zone.
- After the first week, reduce temperature weekly 2–3°C until reaching 21°C.
- Cloacal temperature of the chicks should be 40°C.



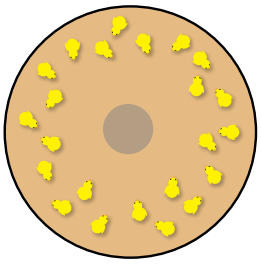
INTERMITTENT LIGHTING PROGRAM FOR CHICKS



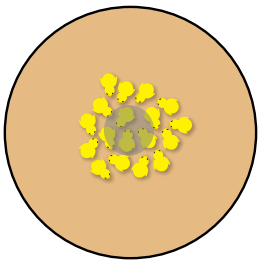
- Preferred lighting technique
- Use from 0–7 days (can be used up to 14 days)
- Intermittent dark periods provide rest periods for chicks
- Synchronizes chicks' activities and feedings
- Establishes more natural pattern of rest and activity
- May improve 7 day livability and pullet body weight
- May improve antibody response from vaccinations
- Some dark periods may be shortened or removed to accommodate work schedules



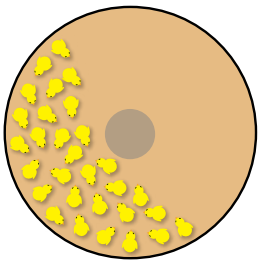
CORRECT
Chicks evenly distributed in brooding area, active and sounding content



HOT
Chicks spread out, lethargic; appear sleeping



COLD
Chicks gathered into groups sounding distressed



UNEVEN VENTILATION
Chicks congregated in one part of brooding area, avoiding drafts, noise or uneven light distribution

CROP FILL – ARE THE CHICKS EATING?

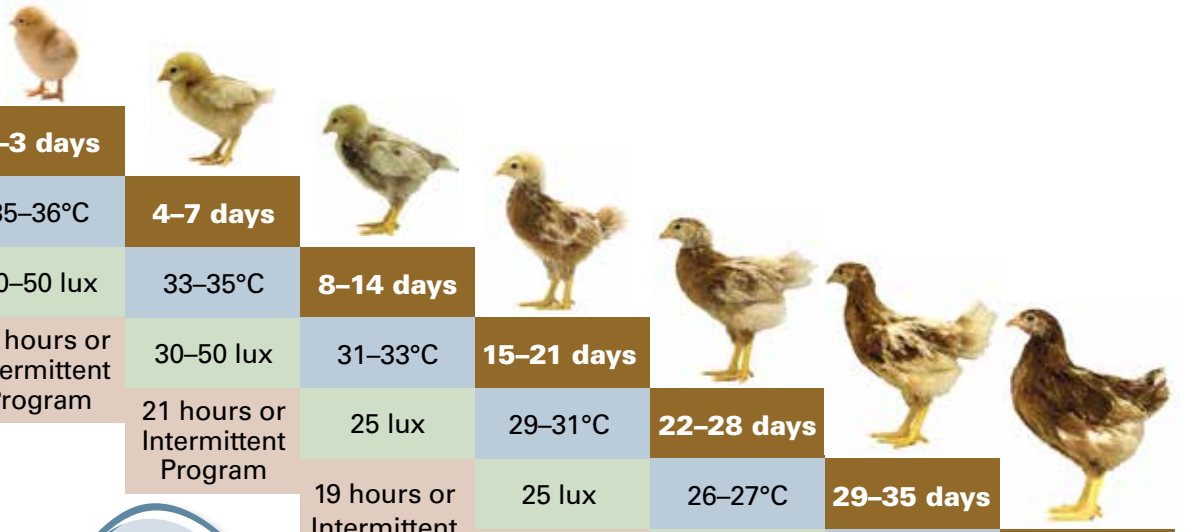
Hours after chick placement	Chicks with feed in crop
6	75%
12	85%
24	100%

Chick with starter feed in crop | *Chick without starter feed in crop*

Brooding temperatures that are too low or too high will decrease the percentage of chicks with crop fill.

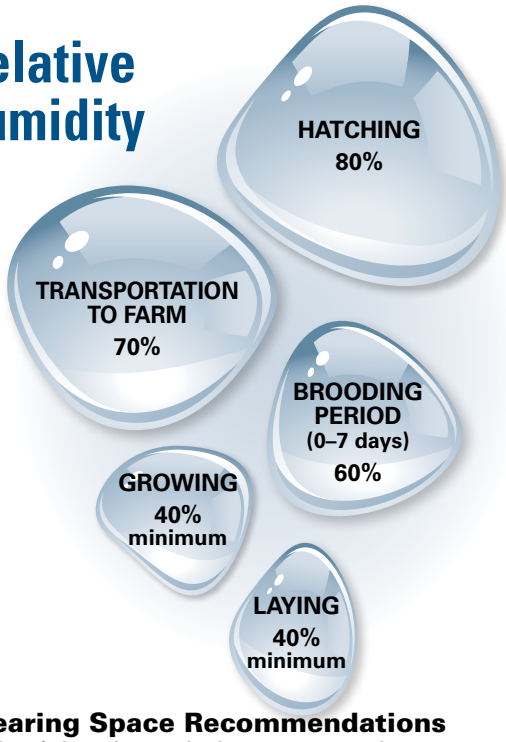
Rope lights can provide uniform lighting to brooding sections in aviary systems. Photo courtesy Big Dutchman.

Growth and Development



AGE	0–3 days	4–7 days	8–14 days	15–21 days	22–28 days	29–35 days	36–42 days
AIR TEMP. (FLOOR)	35–36°C	33–35°C	31–33°C	29–31°C	26–27°C	23–25°C	21°C
LIGHT INTENSITY	30–50 lux	30–50 lux	25 lux	25 lux	25 lux	10–15 lux	10–15 lux
LIGHT HOURS	22 hours or Intermittent Program	21 hours or Intermittent Program	19 hours or Intermittent Program	17.5 hours	16 hours	14.5 hours	13 hours

Relative humidity



Low humidity

- *Reduces bird comfort*
- *Increases dehydration*
- *May result in pasty vents in chicks*
- *May increase agitation and possibility of pecking*
- *Adversely affects feather cover*
- *Increases dust*

Excessive humidity

- *Increases ammonia*
- *Causes poor litter and air quality*

Rearing Recommendations

- Check water availability and raise drinkers as the birds grow (nipples should be higher than the birds' heads, cups should be level with their backs).
- Plan and follow a vaccination schedule specific to your area.
- Greater than 50% of the floor area should be littered.
- Remove and record dead birds daily and dispose of properly. Perform post-mortem examinations if mortality exceeds the performance target to determine the causes of excessive mortality.
- Ensure target body weights are achieved by weekly check weighing. Weigh 60–100 pullets to obtain an average weight.

Rearing Space Recommendations

(check local regulations concerning space requirements)

Useable space is calculated as litter floor and raised slat areas, not including nest space or perch space. If the veranda (winter porch) floor space is considered as useable space when calculating stocking density, then the birds must be able to access this area at all times.

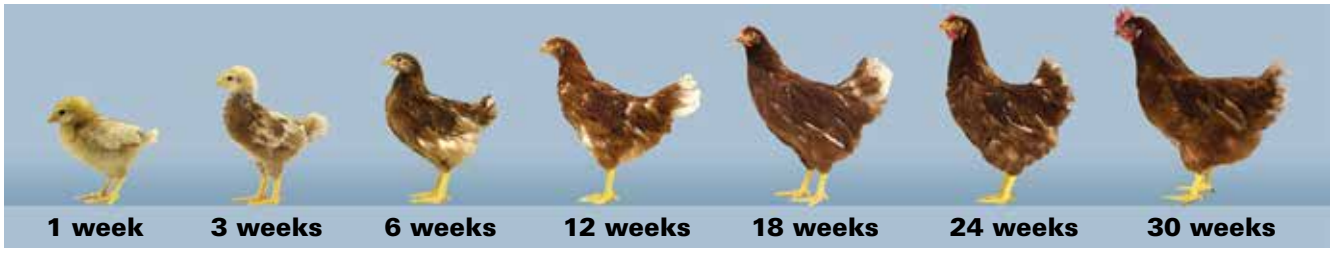
Rearing density depends on age of transfer to the laying house. Use the approximation at right.

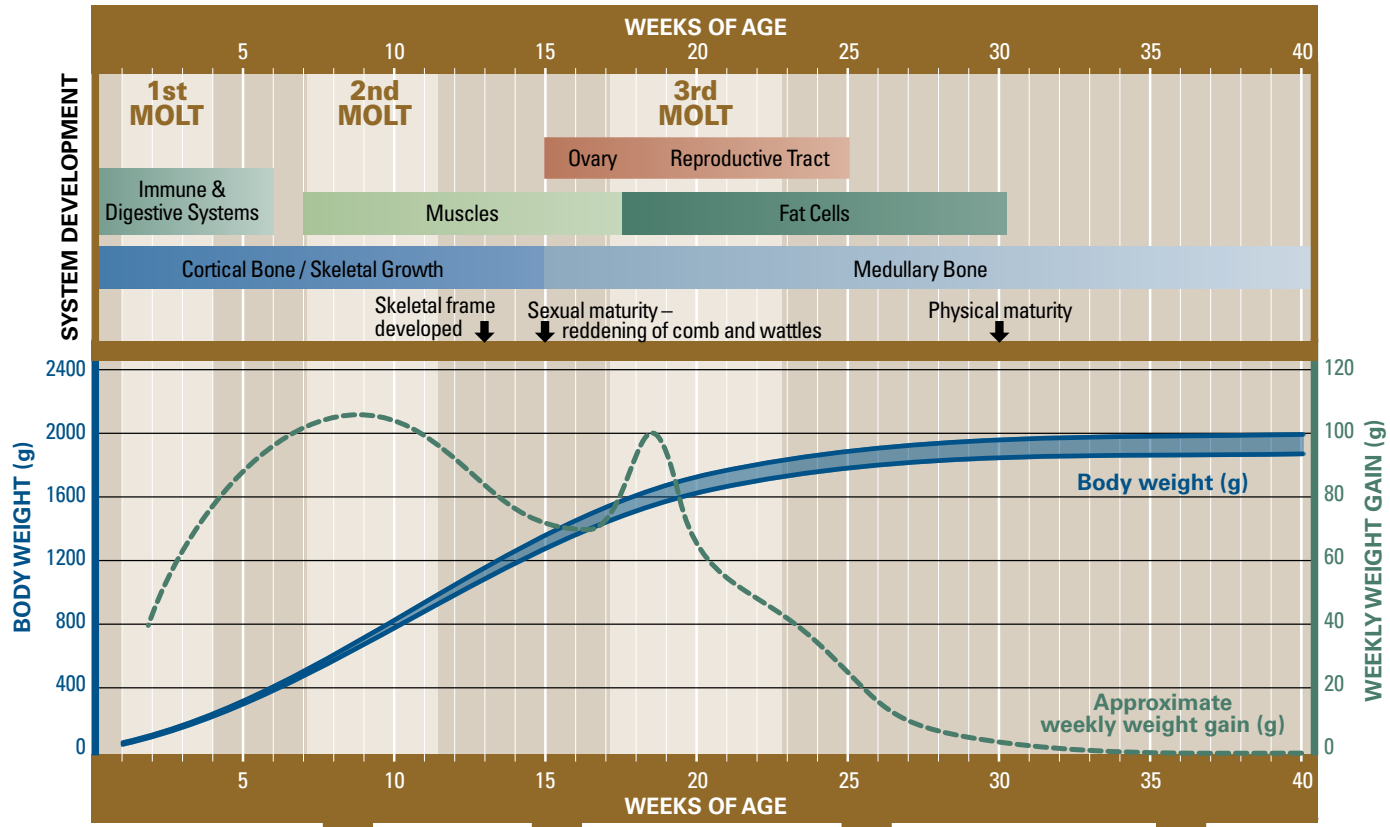
Week of Transfer	Birds/m² of Useable Space
15	15
16	14
17	13
18	12

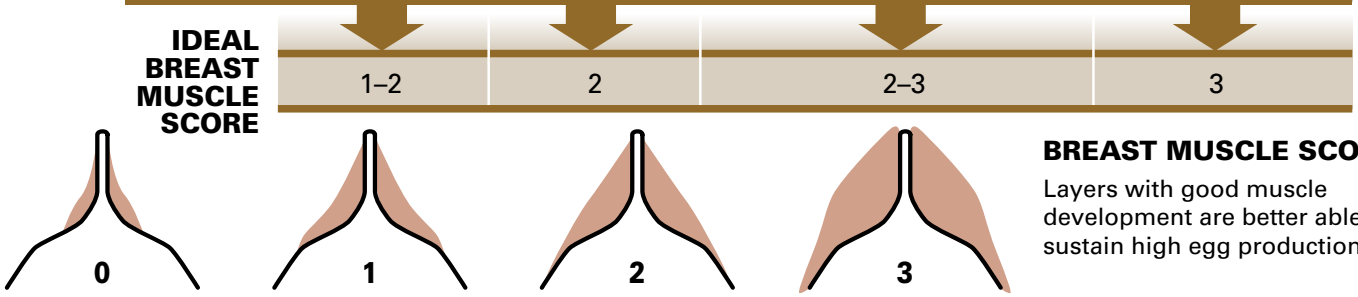
	MULTI-TIER	FLOOR
Floor space	< 20 kg live weight per m² of useable space at 16 weeks when transferred to the laying facility. Adjust stocking density if birds are transferred at other ages.	< 20 kg live weight per m² floor space at end of rearing period
Feeder space	2.5 cm/bird with access on both sides; 5 cm/bird with side access; 2.0 cm/bird with circular feeders	2.5 cm/bird with access on both sides; 5 cm/bird with side access; 2.0 cm/bird with circular feeders
Drinking systems, cups or nipples	12.5 birds per nipple drinker; 20 birds per cup; 125 birds per bell drinker	12.5 birds per nipple drinker; 20 birds per cup; 125 birds per bell drinker
Perch space	10–15 cm/bird	10–15 cm/bird

Growth and Development *(continued)*

- Pullet flocks that enter into egg production at the correct body weight (1.57–1.67 kg) with uniformity higher than 85% perform best in the production period.
- The design of the rearing facility should closely match that of the layer house to which the flock will be transferred. Drinker and feeder type and perching should match. This makes the transition of the birds from rearing to laying easy and stress-free.
- Chicks' body weight should double between arrival and 7 days of age.
- It is important to achieve 6, 12, 18, 24, and 30 week body weight targets to ensure optimum development of the bird's body.
- If possible, exceed pullet body weight standards throughout rear.
- Use a crumble starter feed to promote good feed intake.
- Change rearing diets only when recommended body weight is attained.
- Delay diet change if birds are underweight or have poor body weight uniformity.
- By 12 weeks of age, match the feeding schedule to be used in the layer house.
- During the rearing period, run feeders 3–5 times per day. Feed more frequently to encourage feed intake in underweight flocks or in hot weather. Manage feeders so that additional feedings do not create excessive fine feed particles. Check feed consumption against the body weight/feed consumption table on p. 10.
- Anticipate a rapid rise in ambient temperature and adjust birds' diet accordingly. Birds will eat less when exposed to a rapid temperature increase.
- Delay diet changes until after a stress-inducing event, such as catching birds for an injected vaccination.







BREAST MUSCLE SCORING

Layers with good muscle development are better able to sustain high egg production.

Rearing Body Weights and Uniformity

AGE (weeks)	BODY WEIGHT* (g)	FEED CONSUMPTION (g / bird / day)	CUMULATIVE FEED CONSUMPTION (g / bird)	WATER CONSUMPTION (ml / bird / day)	UNIFORMITY
1	70 – 75	14 – 15	98 – 105	22 – 30	65–70%
2	110 – 125	17 – 21	217 – 252	27 – 42	
3	170 – 190	23 – 25	378 – 427	37 – 50	
4	240 – 270	28 – 30	574 – 637	43 – 58	
5	330 – 360	34 – 36	812 – 889	54 – 72	
6	420 – 465	38 – 40	1078 – 1169	61 – 80	
7	520 – 560	42 – 44	1372 – 1477	66 – 86	
8	620 – 670	53 – 57	1743 – 1876	72 – 94	
9	730 – 780	55 – 59	2128 – 2289	78 – 106	
10	840 – 890	58 – 62	2534 – 2723	83 – 112	70–75%
11	940 – 990	62 – 65	2968 – 3178	93 – 124	
12	1030 – 1080	65 – 69	3423 – 3661	99 – 136	
13	1110 – 1165	69 – 72	3906 – 4165	107 – 142	
14	1190 – 1230	74 – 78	4424 – 4711	112 – 148	80%
15	1260 – 1300	76 – 80	4956 – 5271	115 – 152	
16	1330 – 1370	78 – 82	5502 – 5845	120 – 158	85%
17	1400 – 1440	79 – 83	6055 – 6426	125 – 164	

**During the transfer of birds from rearing to laying facilities there will be some loss of body weight.*

Weigh 100 birds weekly to 30 weeks of age

Weigh birds separately after 3 weeks using a digital scale that calculates uniformity.

Monitoring Body Weights

- Body weights should be monitored weekly up to 30 weeks of age and thereafter every five weeks.
- Weigh birds individually, using a scale with increments no larger than 20 g.
- A minimum of 60 birds should be weighed. In order to get the best representative sample, all birds penned should be weighed.
- Always weigh birds on the same day of the week and at the same time of day.
- Weighing birds weekly will identify when the flocks is deviating from the body weight standard, thus enabling corrective action to be taken.
- It is critical to weigh birds prior to a scheduled feed change. If a flock is below target for body weight, it should remain on a high nutrient density diet until the target weight is reached.
- Factors that can adversely affect body weight include chick and pullet quality, environment, inadequate nutrition, water quality and intake, overcrowding and disease.

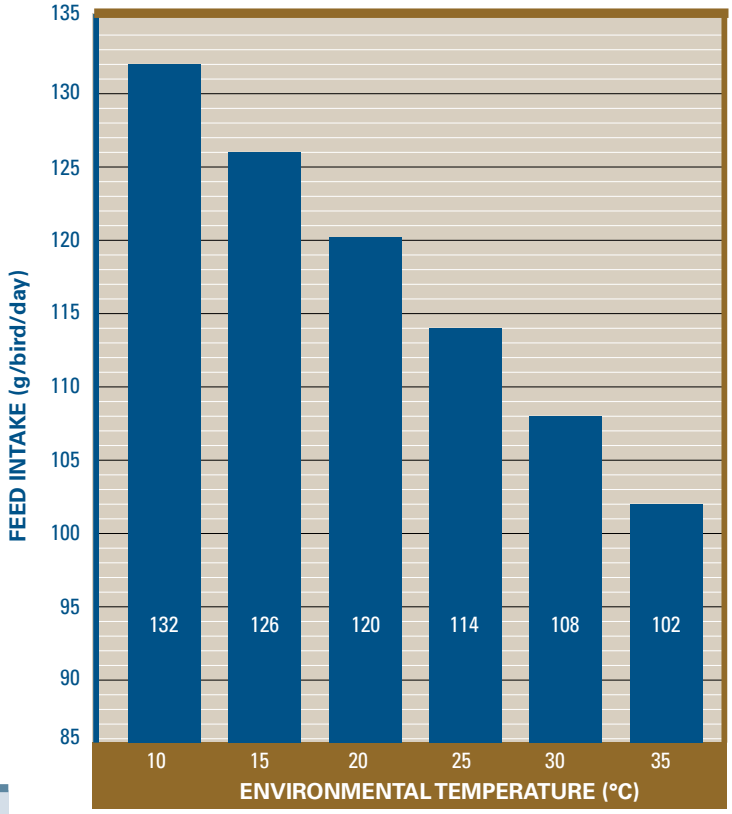
Uniformity

- The uniformity of body weights within a flock is an indicator of flock development.
- Ideally prior to point of lay, flocks should have a minimum uniformity of 85%.
- Uniformity of body weights makes accurate feeding and management of the flock easier.
- Body weight gains and uniformity may be negatively affected by bird handling, vaccination and transfer.
- Using multiple hatch dates, causing a range of chick ages, will negatively affect uniformity.

CALCULATING UNIFORMITY

- Use individual bird weights.
- Uniformity calculation tool is available at www.hylinebodyweight.com.

Approximate Relationship between Feed Consumption and Environmental Temperature



For every 1°C change in ambient temperature, there is an approximate change of 1.2 grams of feed consumption. For example, if temperature is reduced from 20°C to 15°C, feed intake may increase by 6.0 grams/bird per day.

Uniformity *(continued)*

Generally there are two ways of expressing uniformity. The first method is the coefficient of variation (CV).

$$\% \text{ CV} = \frac{\text{Weight Range} \times 100}{\text{Average Weight} \times \text{F value}}$$

F value is a constant based on the sample size (see table below). Weight range is the difference between the lightest and the heaviest bird.

The second way of expressing uniformity is the percentage of birds within +/- 10% of the average weight.

- A desirable goal is for 80% of birds to fall within ±10% of the average weight. For example, if a flock average weight at 18 weeks is 1470 g, 80% of all birds should weigh between 1323 g and 1617 g.
- While this method gives an accurate indication of the number of birds close to the average, it does not (unlike CV%) take into account very light and heavy birds.
- One method of calculation should be used consistently throughout the rearing period, because the numerical result obtained will differ slightly depending on the method used.

Approximate Relationship between CV% and Uniformity

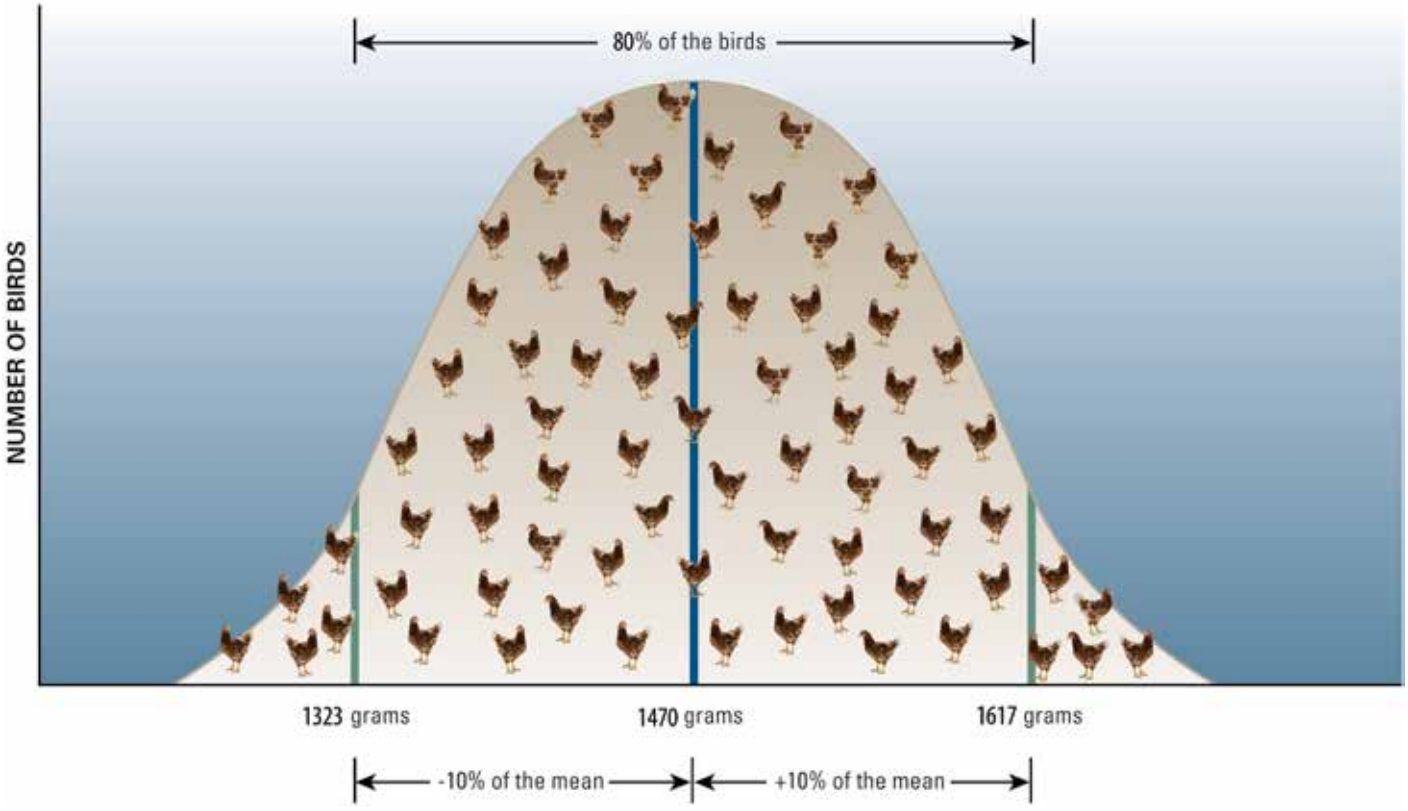
CV%	Uniformity (+/- 10% of average)
5	95.4
6	90.4
7	84.7
8	78.8
9	73.3
10	68.3
11	63.7
12	58.2
13	55.8
14	52.0
15	49.5
16	46.8

Sample Size	F Value
30	4.09
40	4.30
50	4.50
60	4.65
80	4.87
100	5.02

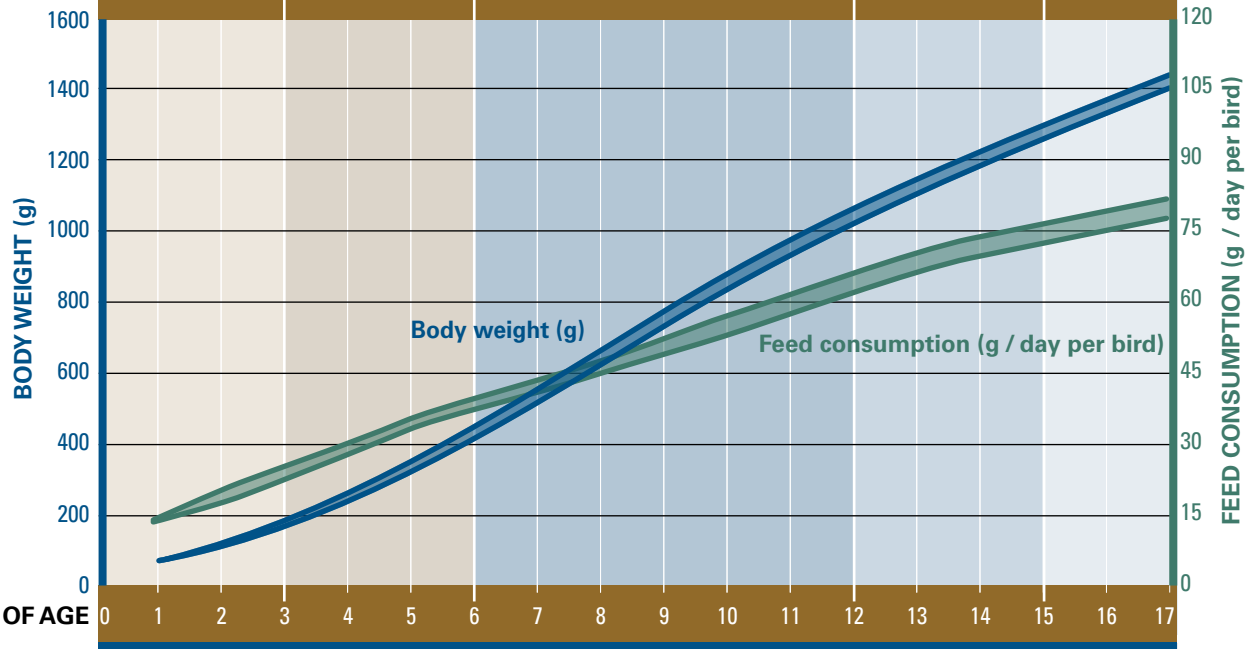
3-week old pullets from the same flock with very different development show the importance of monitoring flock body weight uniformity.

Normal Distribution of Body Weights

Record individual body weights to ensure a bell-shaped or "normal" distribution.



Rearing Period Nutritional Recommendations



NUTRITION	RECOMMENDED NUTRIENT CONCENTRATION				
Metabolizable energy[3], kcal/kg	2867–3043	2867–3043	2800–3021	2734–3021	2778–2999
Metabolizable energy[3], MJ/kg	12.00–12.74	12.00–12.74	11.72–12.64	11.44–12.64	11.63–12.55
	Standardized Ileal Digestible Amino Acids / Total Amino Acids[4]				
Lysine, %	**1.01** / 1.11	**0.92** / 1.01	**0.82** / 0.90	**0.67** / 0.73	**0.72** / 0.79
Methionine, %	**0.45** / 0.49	**0.42** / 0.46	**0.39** / 0.41	**0.31** / 0.34	**0.35** / 0.38
Methionine+Cystine, %	**0.77** / 0.87	**0.72** / 0.81	**0.66** / 0.75	**0.56** / 0.63	**0.62** / 0.70
Threonine, %	**0.65** / 0.76	**0.60** / 0.70	**0.55** / 0.65	**0.46** / 0.54	**0.50** / 0.58
Tryptophan, %	**0.18** / 0.22	**0.17** / 0.21	**0.17** / 0.21	**0.15** / 0.18	**0.16** / 0.19
Arginine, %	**1.05** / 1.13	**0.96** / 1.03	**0.85** / 0.92	**0.70** / 0.75	**0.75** / 0.81
Isoleucine, %	**0.71** / 0.76	**0.66** / 0.71	**0.61** / 0.65	**0.50** / 0.54	**0.56** / 0.60
Valine, %	**0.73** / 0.80	**0.68** / 0.75	**0.64** / 0.71	**0.54** / 0.59	**0.61** / 0.68
Crude protein[5], %	20.00	18.25	17.50	16.00	16.50
Calcium[6], %	1.00	1.00	1.00	1.00	2.50
Phosphorus (available)[7], %	0.45	0.44	0.43	0.45	0.48
Sodium, %	0.18	0.17	0.17	0.18	0.18
Chloride, %	0.18	0.17	0.17	0.18	0.18
Linoleic acid (C18:2 n-6), %	1.00	1.00	1.00	1.00	1.00

[1] Body weights are approximate. Ages shown are a guide only. Please note that at time of transfer, there will be some loss in body weight (normally 10–12%) due to reduced water intake.

[2] Do not feed Pre-Lay Diet earlier than 15 weeks of age. Do not feed Pre-Lay later than first egg as it contains insufficient calcium to support egg production.

[3] Recommended energy range is based on raw material energy values shown in feed ingredient table at back of this guide. It is important that target concentrations of dietary energy are adjusted according to energy system applied to raw material matrix.

[4] Recommendation for Total Amino Acids is only appropriate to corn and soybean meal diet. Where diets utilize other ingredients, recommendations for Standardized Ileal Digestible Amino Acids must be followed.

[5] Diets should always be formulated to provide required intake of amino acid. Concentration of crude protein in diet will vary with raw material used. Crude protein value provided is an estimated typical value only.

[6] Calcium should be supplied as fine calcium carbonate (mean particle size less than 2 mm). Coarse limestone (2–4 mm) can be introduced in Pre-Lay Diet at up to 50% of total limestone.

[7] Where other phosphorus systems are used, diets should contain recommended minimum level of available phosphorus.

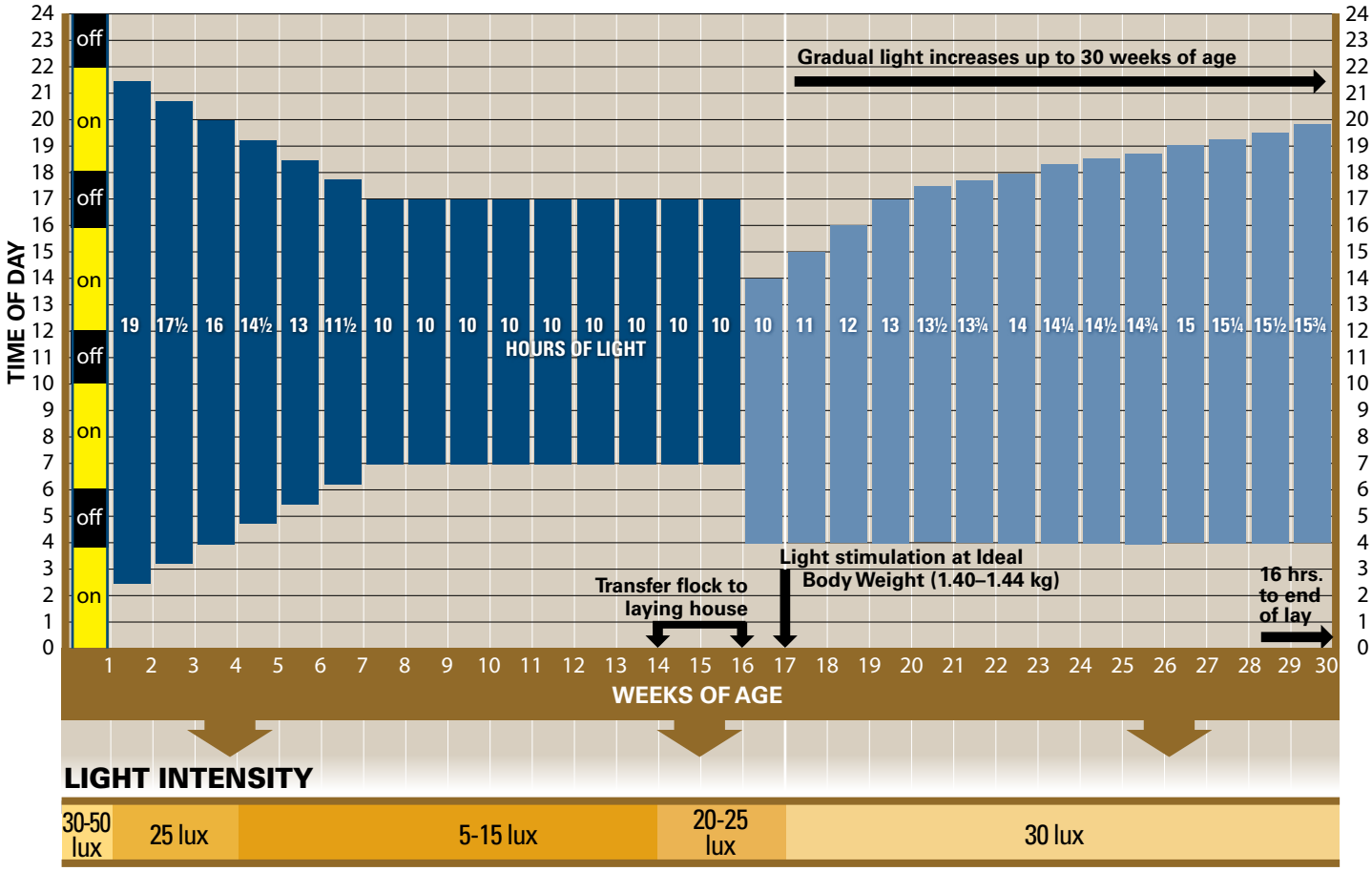
Good Lighting Practices

- In aviary systems, dimming lights gradually to simulate sunset will encourage birds to roost on the upper level.
- Sequentially turn off the lights beginning on the floor level, followed by the middle level and finally the upper level, to get more birds to roost on the upper level at night.
- Verandas (winter porches) should be equipped with lights.
- Keep light bulbs and bulb covers clean to prevent loss of light intensity.
- Prevent dark areas in the house which are caused by too much distance between lights or burned-out light bulbs.
- Shiny or white surfaces reflect light and increase light intensity.
- Take local conditions into account which may require adaptations of lighting programs.
- Light hours of rearing and production houses should be matched at transfer.
- Light stimulation period should extend into the peaking period (achieve 16 hours of light at approximately 30 weeks).
- Light intensity should gradually increase for the 2 weeks before flock is transferred to the laying house (but not prior to 14 weeks of age). Final rearing house light intensity should match the laying house light intensity.
- Free range flocks should use lighting programs designed for open housing. It is important that lights are on in the house when birds are returning from pasture. Birds will not return to a dark house.

Light Program for Light-Controlled Housing

(www.hylineweblighting.com)

Use a slow step-down lighting program for 0–8 weeks to increase the feed intake during the rearing period to optimize pullet flock growth and uniformity.



- An intermittent lighting program is preferred. If not using an intermittent lighting program from 0–7 days, then use 22 hours of light from 0–3 days and 21 hours of light from 4–7 days.
- "Lights on" time can be varied between houses in laying flocks to facilitate egg collection on multiple flock complexes.
- If the laying flock has a large spread in hatch ages and/or poor uniformity, light stimulate the flock based on the youngest hatch date or lightest birds.
- Use "warm" lights (2700–3500 K) in laying flocks to ensure sufficient red spectrum light.
- For more information on poultry lighting, see the "Understanding Poultry Lighting" and "Impact of Tarp Color on Poultry Lighting" technical updates at www.hyline.com.

Customized Lighting Programs for Open-Sided Housing *(www.hylineweblighting.com)*

The Hy-Line International Lighting Program can create custom lighting programs for your location. To prevent early sexual development, the program finds the longest natural day length between 8–17 weeks of age and constructs an artificial lighting program that holds day length constant with artificial lights from 8–17 weeks.

Free range flocks should use lighting programs designed for open housing. It is important that lights are on in the house when birds are returning from pasture. Birds will not return to a dark house.

- *On the first screen—enter e-mail address and select language.*
- *On the second screen, use dropdowns for "Select Location of Flock," "Hatch Date," "Variety Standards" and "Housing Style."*
- *Click on "Create Lighting Spreadsheet."*
- *Results will be e-mailed to you.*

Lighting Program for : IOWA / DALLAS CENTER 93° 56' W

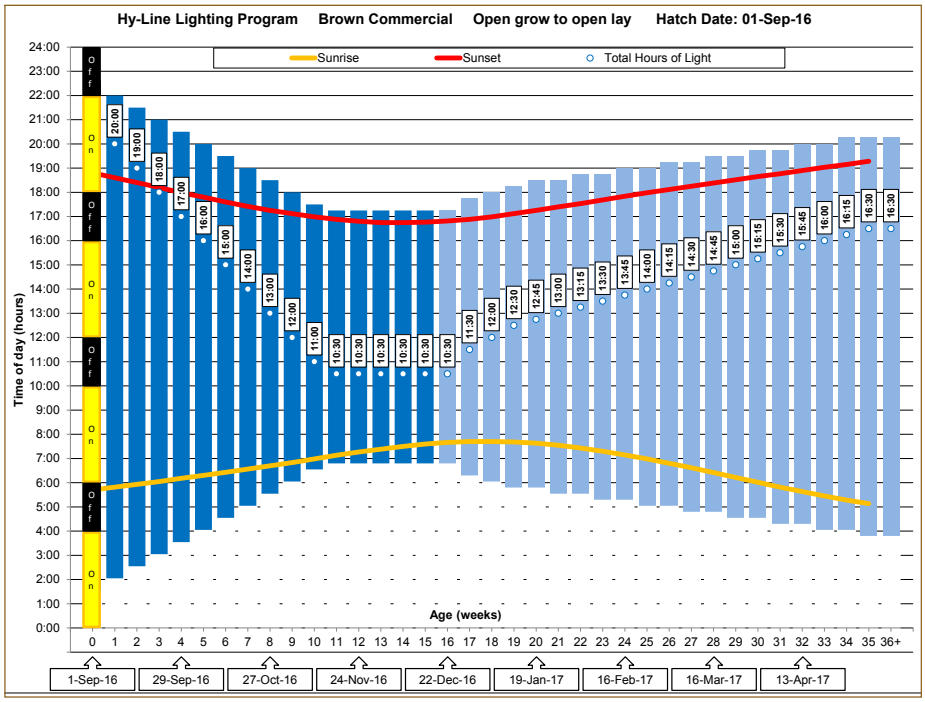
Hy-Line LAYERS

Variety: Brown Commercial
House Type: Open grow to open lay
Hatch Date: 01-Sep-16 Standard daylight time

* Hours of constant

Weeks of Age	Date	Sunrise	Lights on	Lights Off	Sunset	Tota
0	1-Sep-16	5:42	1:30	22:30	18:48	
1	8-Sep-16	5:49	2:00	22:00	18:36	
2	15-Sep-16	5:56	2:30	21:30	18:24	
3	22-Sep-16	6:03	3:00	21:00	18:12	
4	29-Sep-16	6:11	3:30	20:30	17:59	
5	6-Oct-16	6:18	4:00	20:00	17:48	
6	13-Oct-16	6:26	4:30	19:30	17:36	
7	20-Oct-16	6:34	5:00	19:00	17:25	
8	27-Oct-16	6:42	5:30	18:30	17:15	
9	3-Nov-16	6:50	6:00	18:00	17:07	
10	10-Nov-16	6:59	6:30	17:30	16:59	
11	17-Nov-16	7:08	6:45	17:15	16:53	
12	24-Nov-16	7:16	6:45	17:15	16:48	
13	1-Dec-16	7:23	6:45	17:15	16:45	
14	8-Dec-16	7:30	6:45	17:15	16:45	
15	15-Dec-16	7:36	6:45	17:15	16:46	
16	22-Dec-16	7:40	6:45	17:15	16:49	
17	29-Dec-16	7:42	6:15	17:45	16:53	
18	5-Jan-17	7:42	6:00	18:00	16:59	
19	12-Jan-17	7:41	5:45	18:15	17:07	
20	19-Jan-17	7:38	5:45	18:30	17:15	
21	26-Jan-17	7:33	5:30	18:30	17:24	
22	2-Feb-17	7:26	5:30	18:45	17:32	
23	9-Feb-17	7:18	5:15	18:45	17:41	
24	16-Feb-17	7:09	5:15	19:00	17:50	
25	23-Feb-17	6:59	5:00	19:00	17:59	
26	2-Mar-17	6:48	5:00	19:15	18:07	
27	9-Mar-17	6:37	4:45	19:15	18:15	

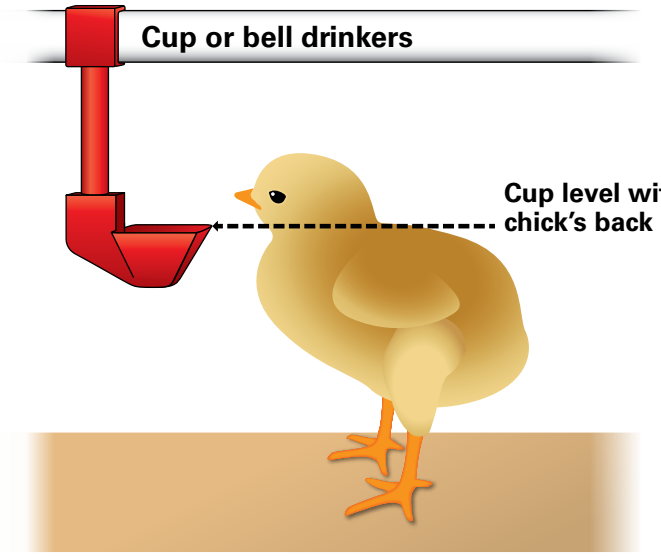
Same lighting program with sunrise and sunset represented by yellow and red lines and suggested artificial day length indicated by blue bars

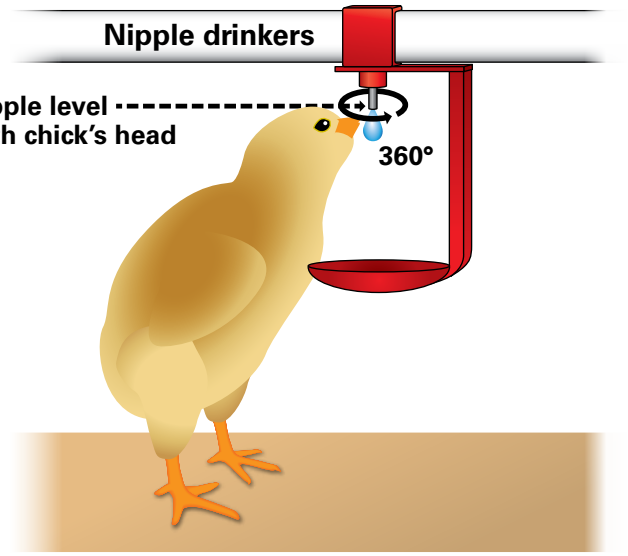


Drinking Systems

The type of drinkers used during rearing should be the same as the ones used in the layer house. Also, use the same nipple type in the rearing house and the laying house (vertical versus 360° activated nipples).

- Water should be kept fresh and clean. Ensure that palatable water is provided for the birds at all times.
- Keep the water fresh and clean by flushing water lines weekly during rearing and production periods. Clean and flush water lines during the night, before lights come on in the morning.
- Record daily flock water consumption. A drop in water consumption is often the earliest indication of a serious problem in the flock.
- Regular water treatment is recommended.
- Ensure the pasture has good drainage—no puddles for birds to access dirty water.
- In aviary systems, the water lines should be in front of nests. Avoid using water lines above the nest level.





- Cup drinkers should be manually filled during 0–3 days to train chicks to drink.
- Open drinkers (bell, supplemental chick drinkers, trough) are easily contaminated and should be cleaned daily.
- Nipple drinking systems are preferred because they are closed and thus more sanitary.
- Adjust nipple water system pressure to create hanging drop to help chicks find water for 0–3 days and in layer house at transfer for 7 days.
- Splash cups are useful during brooding period and in hot climates.
- 360° activated nipples make drinking easy for chicks.
- Use only 360° activated nipples for hatchery beak-treated chicks, as well as supplemental chick drinkers.
- Nipple drinkers should deliver a minimum 60 ml per minute / nipple in layers.

Air Quality

- Production house should be at 18–25°C and 40–60% humidity.
- The general rule for determining required fan capacity—4 m^3 of air movement / kilogram of body weight per hour.
- Ventilation is essential to:
  - Provide each bird with an adequate supply of oxygen
  - Remove moisture from house
  - Remove carbon dioxide produced by birds
  - Remove dust particles
  - Dilute aerosolized pathogenic organisms
- Positive pressure houses where exhaust air is exiting through vents and popholes prevents cold damp air in winter from entering the house and causing wet litter.
- In tunnel ventilated houses, if birds are confined inside the house due to hot weather, ensure that the stocking densities are appropriate for bird confinement.
- Allowable levels of noxious gases at floor level in the house are: ammonia (NH_3) < 25 ppm; carbon dioxide (CO_2) < 5000 ppm; carbon monoxide (CO) < 50 ppm (measured over 8 hours).

Air Movement (m^3 / hour per 1000 birds)

AMBIENT TEMP. (°C)	WEEKS OF AGE					
	1	3	6	12	18	19+
32	360	540	1250	3000	7140	9340–12000
21	180	270	630	1500	3050	5100–6800
10	130	180	420	800	2240	3060–4250
0	75	136	289	540	1500	1020–1700
-12	75	110	210	400	600	700–1050
-23	75	110	210	400	600	700–850

Acknowledgment: Dr. Hongwei Xin, Professor, Department of Agriculture and Biosystems Engineering and Department of Animal Science, Iowa State University, Ames, Iowa, USA

Water Quality

- Good quality water must be available to birds at all times.
- Water and feed consumption are directly related—when birds drink less, they consume less feed, and production quickly declines.
- As a general rule, healthy birds will consume 1.5–2.0 times more water than feed. This ratio increases in high ambient temperatures.
- High concentrations of sodium or other minerals may require changes in ration formulation.
- Test water quality at least 1 time per year. The water source will determine the regularity of water testing.
  - Surface water requires more frequent testing, as it is more affected by season and rainfall patterns.
  - Closed wells taking water from aquifers or deep artesian basins will be more consistent in water quality, but are generally higher in dissolved mineral content.
- The presence of coliform bacteria is an indicator that the water source has been contaminated with animal or human waste.
- When collecting a well water sample, let the water run for 2 minutes prior to collecting the sample. Water samples should be kept below 10°C and submitted to the lab in less than 24 hours.
- Some water sources contain high levels of dissolved minerals such as calcium, sodium and magnesium. When this occurs, amounts of these minerals in water have to be considered when formulating feed.
- Drinking water should be tested for quality and cleanliness from source and end of the water line.
- Preferable drinking water temperature for chicks is 20–25°C and for layers is 15–20°C.
- Ideal water pH is 5–7 to promote good water sanitation, increase feed consumption and improve upper gastrointestinal health.
- Less than optimum water quality can have a significant impact on intestinal health, which will lead to under utilization of nutrients in feed.
- A decrease in flock water consumption is often the first sign of disease problems and production drops.

ITEM	MAXIMUM CONCENTRATION (ppm or mg/L)*	
Nitrate NO_3^- [1]	25	Older birds will tolerate higher levels up to 20 ppm. Stressed or diseased challenged birds may be more sensitive to effects of Nitrate.
Nitrate Nitrogen (NO_3-N) [1]	6	
Nitrite NO_2^- [1]	4	Nitrite is considerably more toxic than Nitrate, especially for young birds, where 1 ppm Nitrite may be considered toxic.
Nitrite Nitrogen (NO_2-N) [1]	1	
Total dissolved solids [2]	1000	Levels up to 3000 ppm may not affect performance but could increase manure moisture.
Chloride (Cl^-) [1]	250	Levels as low as 14 mg may be problematic if sodium is higher than 50 ppm.
Sulfate (SO_4^-) [1]	250	Higher levels may be laxative.
Iron (Fe) [1]	<0.3	Higher levels result in bad odor and taste.
Magnesium (Mg) [1]	125	Higher levels may be laxative. Levels above 50 ppm may be problematic if sulphate levels are high.
Potassium (K) [2]	20	Higher levels may be acceptable depending on sodium level, alkalinity and pH.
Sodium (Na) [1,2]	50	Higher concentration is acceptable but concentrations above 50 ppm should be avoided if high levels of chloride, sulphate or potassium exist.
Manganese (Mn) [3]	0.05	Higher levels may be laxative.
Arsenic (As) [2]	0.5	
Fluoride (F^-) [2]	2	
Aluminum (Al) [2]	5	
Boron (B) [2]	5	
Cadmium (Cd) [2]	0.02	
Cobalt (Co) [2]	1	
Copper (Cu) [1]	0.6	Higher levels result in bitter taste.
Lead (Pb) [1]	0.02	Higher levels are toxic.
Mercury (Hg) [2]	0.003	Higher levels are toxic.
Zinc (Zn) [1]	1.5	Higher levels are toxic.
pH [1]	6.3–7.5	Birds may adapt to lower pH. Below pH 5 may reduce water intake and corrode metal fittings. Above pH 8 may reduce intake and reduce effectiveness of water sanitation.
Total bacteria counts [3]	1000 CFU/ml	This is likely to indicate dirty water.
Total Coliform bacteria [3]	50 CFU/ml	
Fecal Coliform bacteria [3]	0 CFU/ml	
Oxygen Reduction Potential (ORP) [3]	650–750 mEq	The ORP range at which 2–4 ppm of free chlorine will effectively sanitize water at a favorable pH range of 5–7.

*Limits may be lower as interactions exist between magnesium and sulphate; and between sodium, potassium, chloride and sulphate.

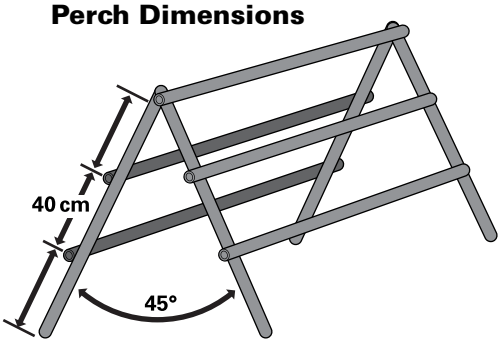
[1] Carter & Sneed, 1996. Drinking Water Quality for Poultry, Poultry Science and Technology Guide, North Carolina State University Poultry Extension Service. Guide no. 42

[2] Marx and Jaikaran, 2007. Water Analysis Interpretation. Agri-Facts, Alberta Ag-Info Centre. Refer to http://www.agric.gov.ab.ca/app84/rwqit for online Water Analysis Tool

[3] Watkins, 2008. Water: Identifying and Correcting Challenges. Avian Advice 10(3): 10–15 University of Arkansas Cooperative Extension Service, Fayetteville

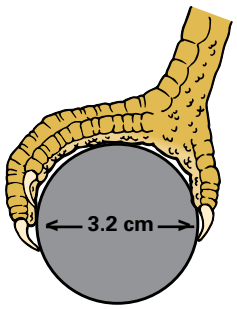
Perches

Perch Dimensions



- Perches are essential for rearing birds that will go into an aviary system.
- They enrich the birds' environment and allow expression of normal behaviors.
- Perches encourage jumping habits, which develops leg and breast muscles, increases bone strength and calcium content of bone. Birds able to jump will have good nesting behavior and be more mobile in multi-tier aviary systems.
- Perches reduce social stress by providing safe resting sites.
- Perches increase living space in house.
- Perches allow birds to roost at night.
- Use of perches may reduce piling behavior in flocks.

Perch Design



- Floor-reared birds should have access to perches and slats no later than 10 days of age.
- Perch height should not exceed 1 m to avoid injuries.
- Provide 10–15 cm perch space per bird (check local regulations concerning perch space).
- Separate perch rails by at least 30 cm to prevent cannibalistic pecking of birds on adjacent rails.
- Place perches on slats to maintain good litter conditions and control floor eggs.
- Avoid slippery perches.
- Perches should be round or rectangular for better gripping and comfort.
- Perches should support bottom of foot.
- If possible, use the same perch style in rear and lay houses.
- Don't use perches above water lines during rear if using an electric deterrent over water line in production.
- Perches should be easy to clean and disinfect between flocks.
- Seal cracks, crevices and open ends of pipes to reduce hiding areas of red mites (*Dermanyssus gallinae*).
- Perches are ideally placed over feed lines and on the top level in aviaries.

PERCH EXAMPLES

Wall perch

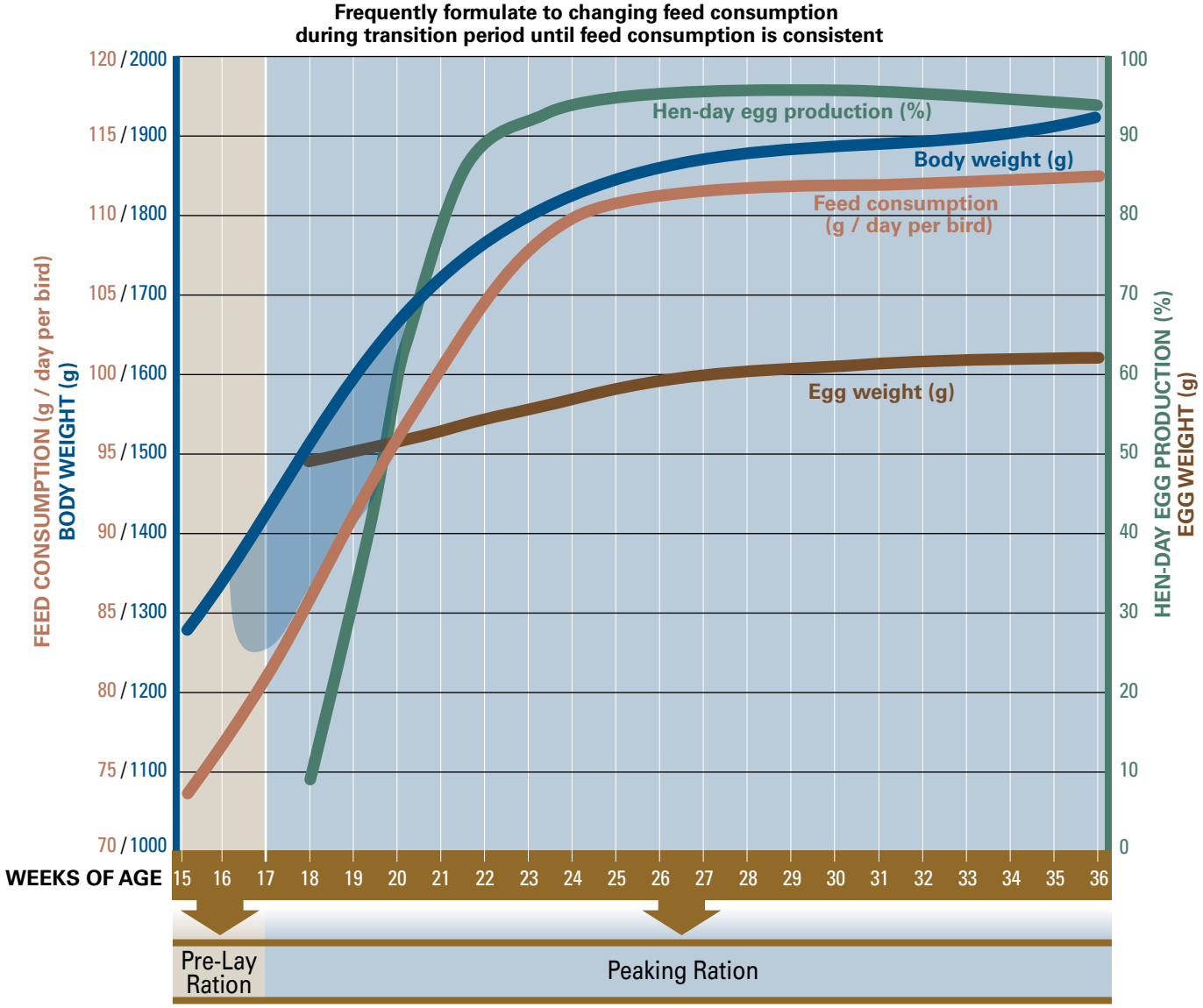
Perch over feeder

A-frame perch with slats

Perch in aviary system

Elevated platform

Transition Period from Rear to Peak Egg Production



* Blue shaded area represents potential body weight losses during transfer.

Transition Period

- During the transition period, nutrient requirements increase dramatically.
- Occurring during the transition period:
  - Rapidly increasing egg production
  - Increasing egg size
  - Increasing body weight
- Feed consumption may increase slowly during transition:
  - In underweight birds
  - In flocks lacking uniformity
  - During high environmental temperatures
- Poor uniformity prolongs the transition period and may result in low peak and poor persistency of production.
- Monitor feed intake and egg production carefully during transition and adjust dietary nutrient concentration accordingly.

Pre-Lay Ration

- Feed when most pullets show reddening of combs.
- Pre-Lay Diet is important to increase medullary bone reserves in pullets prior to egg production. Medullary bone is the form of bone that is quickly mobilized for eggshell formation.
- Plan to feed for maximum of 7–14 days before point of lay.
- Begin introducing large particle calcium into the diet beginning with the Pre-Lay Diet.
- Discontinue Pre-Lay Diet with the commencement of egg production.

Peaking Ration

- Formulations for low feed intakes (88–95 g / day per bird) may be required to meet the hen's nutrient requirements. Increase vitamin and trace mineral levels in these low intake diets.
- Begin Peaking Diet with onset of lay (1% egg production).
- Feed intake may be reduced if birds are not accustomed to large particle calcium (i.e. use of a Pre-Lay Diet).
- Ensure that Peaking Diet is in the feeders when first eggs are laid, not in the feed bin.

Transition Period from Rear to Peak Egg Production *(continued)*

Transfer to the Laying House

- Barn, aviary and free range birds must be transferred to the layer house a minimum of 14 days before the first egg. This is typically between 14–16 weeks of age.
- Earlier transfer makes it easier for birds to adapt to their new laying environment prior to the onset of egg production.
- Two weeks prior to moving, gradually increase light intensity to match the laying house.
- Light hours of rearing and production house should be matched at transfer.
- Three days before moving pullets to the laying house, begin using water-soluble vitamins and electrolytes in the drinking water to relieve stress.
- Transfer birds quickly to laying house, and transfer all birds the same day. Move early in the morning so birds can keep to a normal daily routine.
- Water consumption during the last week on the rearing farm should be noted and compared with water consumption in the laying house immediately after transfer. The time taken to match the previous level of water consumption and subsequently exceed it will be an indication of how well the birds have adapted to their new environment. Birds should be drinking normally by 6 hours after transfer.
- For the first week, keep nipple drinkers lowered after transfer to slightly above the bird's back before raising them to head level.
- Leave lights on at night for the first few nights after transfer to reduce the risk of birds piling.
- Increase light intensity for first 2–3 days to help birds adapt to their new environment.
- House temperature at transfer of 15–20°C will encourage feed intake.
- Before transfer, the flock should be treated for worms and have resistance against coccidia through the use of coccidiostats in the feed or by vaccination.

Barn Systems

- In barn systems with both litter and elevated slat areas, place females on slats when moving to the production house.
- Plastic fencing can be temporarily used to retain birds on the slatted area for a few days to ensure they quickly become familiar with drinkers, feeders and nests.

Aviary Systems

- The best pullets are reared in an aviary system and trained to use an aviary system from the first day of life.
- Place birds inside the aviary system when transferring the flock. It is important that all birds are in the aviary system before lights go off at night. This may require manually placing floor birds into the system until they are trained to sleep in the system.
- Some aviary systems allow birds to be retained within the system for a few days after transfer to learn to use the feeders, waterers and nests before egg production begins.
- It is advisable to retain the hens within the aviary system if coming from floor rearing houses.
- Rearing birds in intensive systems to go into aviary and barn laying facilities is not recommended.

Body Weight Loss of Birds in Transit

It should be noted that at the time of transfer from rearing to laying houses, there will be some loss in body weight (which is normally 10–12%). This loss is mainly due to reduced water intake and some dehydration of the pullet.

To help regain these losses, the following factors should be considered.

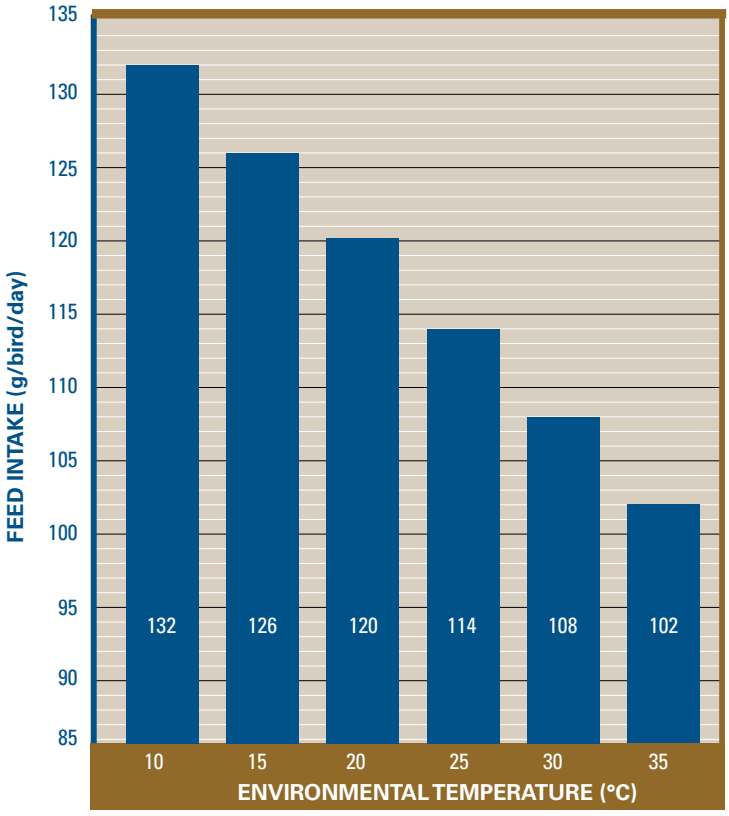
- Age of transfer (earlier transfers are less stressful).
- Availability of fresh potable water, monitoring intake levels to ensure good uptake.
- Availability of fresh feed, similar in physical quality and nutrient profile to the feed used in the rearing house just before transfer.
- Match lighting programs between rearing and laying houses.
- Match drinker and feeder type between rearing and laying.
- Care must be taken in hot or cold ambient conditions to maintain an appropriate house temperature.
- Ensure laying house environment is set up and ready for pullets.
- Ensure birds are moved with welfare as a priority.

Plastic fencing is used to temporarily retain birds on slatted area after transfer to train birds to have correct eating, drinking and sleeping behaviors.

Feed Consumption

- Hens should have access to feed at all times.
- A phase-feeding program should be practiced to ensure correct nutrient consumption throughout lay. Phase feeding matches nutrient intake with performance and desired egg size.
- Layer diets should be formulated according to the actual feed consumption and level of desired production.
- Reduce feed tracks to a lower level in the middle of the day to ensure the consumption of smaller feed particles.
- Stimulate feed consumption by running feeders without adding additional feed. Manage feeders so that additional feedings do not create excessive fine feed particles.
- The hens' feed consumption rate is governed by several factors, including body weight (or age), rate of egg production, egg weight, ambient temperature, feed texture and dietary energy content.
- Hy-Line Brown has a limited ability to adjust their feed consumption to meet their needs for specific nutrients.
- After 10 weeks of age, hens tend to increase or decrease feed consumption to maintain energy intake—in other words, hens will consume more of a low-energy diet than a high-energy diet.
- Heat stress results in lower feed and energy consumption. Increasing the energy content in the feed can result in better body weight gain, egg production and egg weight when the effective ambient temperature is high. For more information on heat stress management, see the "Understanding Heat Stress in Layers" technical update at www.hyline.com.
- Fats or oils are concentrated sources of energy and can be useful in increasing the energy content and palatability of feed.
- Vegetable oils are typically high in linoleic acid, which tends to increase egg size. A blend of vegetable oils may also be acceptable.

Approximate Relationship between Feed Consumption and Environmental Temperature

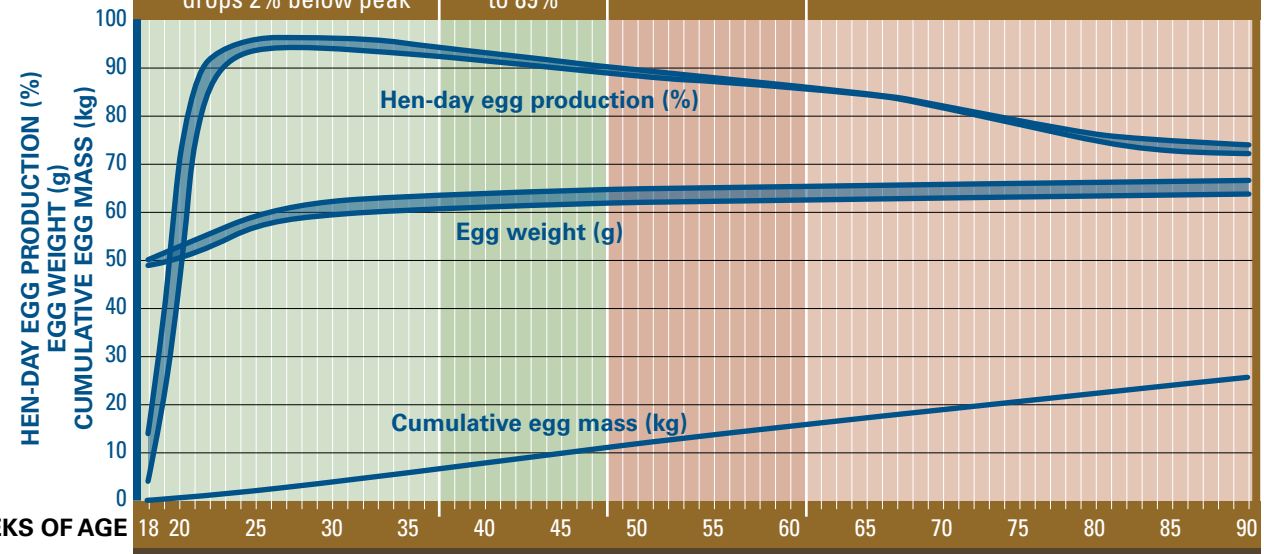


For every 1°C change in ambient temperature, there is an approximate change of 1.2 grams of feed consumption. For example, if temperature is reduced from 20°C to 15°C, feed intake may increase by 6.0 grams/bird per day.

Production Period Space Recommendations

Floor	7–9 birds/m^2 of useable space. Higher stocking densities can be used in aviary systems. Consult equipment manufacturers.
Feeders	5cm/bird (with access on both sides); 10 cm/bird (with access on one side); 4 cm/bird with circular feeders
Drinkers	Nipples/cups: 1 per 10 birds; circular drinkers: 1 cm/bird; linear drinker: 2.5 cm per bird
Perches	10–15 cm/bird
Nests	5 birds/nest or 120 birds per m^2 in colony nests

Production Period Nutritional Recommendations



NUTRITION	RECOMMENDED NUTRIENT INTAKE[1]			
Metabolizable energy[2], kcal/kg	2796–2916	2749–2868	2701–2820	2629–2749
Metabolizable energy[2], MJ/kg	11.70–12.20	11.50–12.00	11.30–11.80	11.00–11.50
	Standardized Ileal Digestible Amino Acids / Total Amino Acids[3]			
Lysine, mg/day	**830** / 909	**800** / 876	**780** / 854	**750** / 821
Methionine, mg/day	**407** / 437	**392** / 422	**382** / 411	**360** / 387
Methionine+Cystine, mg/day	**714** / 805	**688** / 776	**663** / 748	**630** / 711
Threonine, mg/day	**581** / 684	**560** / 659	**546** / 642	**525** / 618
Tryptophan, mg/day	**174** / 208	**168** / 201	**164** / 196	**158** / 188
Arginine, mg/day	**863** / 928	**832** / 895	**811** / 872	**780** / 839
Isoleucine, mg/day	**647** / 696	**624** / 671	**608** / 654	**585** / 629
Valine, mg/day	**730** / 806	**704** / 776	**686** / 757	**660** / 728
Crude protein[4], g/day	17.00	16.75	16.00	15.50
Sodium, mg/day	180	180	180	180
Chloride, mg/day	180	180	180	180
Linoleic acid (C18:2 n-6), g/day	1.00	1.00	1.00	1.00
Choline, mg/day	100	100	100	100

CALCIUM, PHOSPHORUS AND LIMESTONE PARTICLE SIZE CHANGES BASED ON AGE	Weeks 17–37	Weeks 38–48	Weeks 49–61	Weeks 62–90
Calcium[5,6], g/day	4.20	4.30	4.50	4.80
Phosphorus (available)[5,7], mg/day	460	420	380	360
Calcium Particle Size (fine:coarse)	50% : 50%	40% : 60%	35% : 65%	35% : 65%

[1] Crude protein, methionine+cystine, fat, linoleic acid, and / or energy may be changed to optimize egg size.

[2] Recommended energy range is based on energy values shown in feed ingredient table at back of this guide. It is important that target concentrations of dietary energy are adjusted according to energy system applied to raw material matrix if values differ from those referred for raw materials in this guide.

[3] Recommendation for Total Amino Acids is only appropriate to corn and soybean meal diet. Where diets utilize other ingredients, recommendations for Standardized Ileal Digestible Amino Acids must be followed.

[4] Diets should always be formulated to provide required intake of amino acid. Concentration of crude protein in diet will vary with raw material used. Crude protein value provided is an estimated typical value only.

[5] Calcium and available phosphorus requirements are determined by flock age. When production remains higher and diets are fed for longer than ages shown, it is recommended to increase to calcium and phosphorus concentrations of next feeding phase.

[6] Calcium carbonate particle size recommendation varies throughout lay. Refer to Calcium Particle Size Table. Dietary calcium levels may need to be adjusted based on limestone solubility.

[7] Where other phosphorus systems are used, diets should contain recommended minimum level of available phosphorus.

Dietary Nutrient Concentrations for Production Period *(According to Phase and Feed Intake)*

FEEDING PHASE / PRODUCTION	PEAKING — First egg until production drops 2% below peak						LAYER 2 — 2% below peak to 89%					LAYER 3 — 88–85%					LAYER 4 — Less than 85%				
NUTRITION	**RECOMMENDED CONCENTRATION**																				
Metabolizable energy, kcal/kg	2796–2916						2748–2868					2701–2820					2629–2749				
Metabolizable energy, MJ/kg	11.70–12.20						11.50–12.00					11.30–11.80					11.00–11.50				
	FEED CONSUMPTION (*Typical Feed Consumption)																				
g/day per bird	100	105	110	**115***	120	125	105	110	**115***	120	125	100	105	**110***	115	120	100	105	**110***	115	120
	Standardized Ileal Digestible Amino Acids																				
Lysine, %	0.83	0.79	0.75	**0.72**	0.69	0.66	0.76	0.73	**0.70**	0.67	0.64	0.78	0.74	**0.71**	0.68	0.65	0.75	0.71	**0.68**	0.65	0.63
Methionine, %	0.41	0.39	0.37	**0.35**	0.34	0.33	0.37	0.36	**0.34**	0.33	0.31	0.38	0.36	**0.35**	0.33	0.32	0.36	0.34	**0.33**	0.31	0.30
Methionine+Cystine,%	0.71	0.68	0.65	**0.62**	0.60	0.57	0.66	0.63	**0.60**	0.57	0.55	0.66	0.63	**0.60**	0.58	0.55	0.63	0.60	**0.57**	0.55	0.53
Threonine, %	0.58	0.55	0.53	**0.51**	0.48	0.46	0.53	0.51	**0.49**	0.47	0.45	0.55	0.52	**0.50**	0.47	0.46	0.53	0.50	**0.48**	0.46	0.44
Tryptophan, %	0.17	0.17	0.16	**0.15**	0.15	0.14	0.16	0.15	**0.15**	0.14	0.13	0.16	0.16	**0.15**	0.14	0.14	0.16	0.15	**0.14**	0.14	0.13
Arginine, %	0.86	0.82	0.78	**0.75**	0.72	0.69	0.79	0.76	**0.72**	0.69	0.67	0.81	0.77	**0.74**	0.71	0.68	0.78	0.74	**0.71**	0.68	0.65
Isoleucine, %	0.65	0.62	0.59	**0.56**	0.54	0.52	0.59	0.57	**0.54**	0.52	0.50	0.61	0.58	**0.55**	0.53	0.51	0.59	0.56	**0.53**	0.51	0.49
Valine, %	0.73	0.70	0.66	**0.63**	0.61	0.58	0.67	0.64	**0.61**	0.59	0.56	0.69	0.65	**0.62**	0.60	0.57	0.66	0.63	**0.60**	0.57	0.55
	Total Amino Acids																				
Lysine, %	0.91	0.87	0.83	**0.79**	0.76	0.73	0.83	0.80	**0.76**	0.73	0.70	0.85	0.81	**0.78**	0.74	0.71	0.82	0.78	**0.75**	0.72	0.69
Methionine, %	0.44	0.415	0.40	**0.38**	0.36	0.35	0.40	0.38	**0.37**	0.35	0.34	0.41	0.39	**0.37**	0.36	0.34	0.39	0.37	**0.35**	0.34	0.32
Methionine+Cystine,%	0.80	0.76	0.73	**0.70**	0.67	0.64	0.74	0.71	**0.67**	0.65	0.62	0.75	0.71	**0.68**	0.65	0.62	0.71	0.67	**0.64**	0.62	0.59
Threonine, %	0.69	0.65	0.62	**0.60**	0.57	0.55	0.63	0.60	**0.57**	0.55	0.53	0.64	0.61	**0.58**	0.56	0.54	0.62	0.59	**0.56**	0.54	0.52
Tryptophan, %	0.21	0.20	0.19	**0.18**	0.17	0.16	0.19	0.18	**0.17**	0.17	0.16	0.20	0.19	**0.18**	0.17	0.16	0.19	0.18	**0.17**	0.16	0.16
Arginine, %	0.92	0.88	0.84	**0.80**	0.77	0.74	0.85	0.81	**0.78**	0.75	0.72	0.87	0.83	**0.79**	0.76	0.73	0.84	0.80	**0.76**	0.73	0.70
Isoleucine, %	0.69	0.66	0.63	**0.60**	0.58	0.56	0.64	0.61	**0.58**	0.56	0.54	0.65	0.62	**0.59**	0.57	0.55	0.63	0.60	**0.57**	0.55	0.53
Valine, %	0.81	0.77	0.73	**0.70**	0.67	0.65	0.74	0.71	**0.67**	0.65	0.62	0.76	0.72	**0.69**	0.66	0.63	0.73	0.69	**0.66**	0.63	0.61
Crude protein, %	17.00	16.19	15.45	**14.78**	14.17	13.60	15.95	15.23	**14.57**	13.96	13.40	16.00	15.24	**14.55**	13.91	13.33	15.50	14.76	**14.09**	13.48	12.92
Sodium, %	0.18	0.17	0.16	**0.16**	0.15	0.14	0.17	0.16	**0.16**	0.15	0.14	0.18	0.17	**0.16**	0.16	0.15	0.18	0.17	**0.16**	0.16	0.15
Chloride, %	0.18	0.17	0.16	**0.16**	0.15	0.14	0.17	0.16	**0.16**	0.15	0.14	0.18	0.17	**0.16**	0.16	0.15	0.18	0.17	**0.16**	0.16	0.15
Linoleic acid (C18:2 n-6), %	1.00	0.95	0.91	**0.87**	0.83	0.80	0.95	0.91	**0.87**	0.83	0.80	1.00	0.95	**0.91**	0.87	0.83	1.00	0.95	**0.91**	0.87	0.83

	CALCIUM, PHOSPHORUS AND LIMESTONE PARTICLE SIZE CHANGES BASED ON AGE																				
	Weeks 17–37						Weeks 38–48					Weeks 49–61					Weeks 62–90				
Feed Consumption, g/day per bird	100	105	110	**115***	120	125	105	110	**115***	120	125	100	105	**110***	115	120	100	105	**110***	115	120
Calcium, %	4.20	4.00	3.82	**3.65**	3.50	3.36	4.10	3.91	**3.74**	3.58	3.44	4.50	4.29	**4.09**	3.91	3.75	4.80	4.57	**4.36**	4.17	4.00
Phosphorus (available), %	0.46	0.44	0.42	**0.40**	0.38	0.37	0.40	0.38	**0.37**	0.35	0.34	0.38	0.36	**0.35**	0.33	0.32	0.36	0.34	**0.33**	0.31	0.30
Calcium Particle Size (fine:coarse)	50% : 50%						40% : 60%					35% : 65%					35% : 65%				

[1] Crude protein, methionine+cystine, fat, linoleic acid, and / or energy may be changed to optimize egg size.

[2] Recommended energy range is based on energy values shown in feed ingredient table at back of this guide. It is important that target concentrations of dietary energy are adjusted according to energy system applied to raw material matrix if values differ from those referred for raw materials in this guide.

[3] Recommendation for Total Amino Acids is only appropriate to corn and soybean meal diet. Where diets utilize other ingredients, recommendations for Standardized Ileal Digestible Amino Acids must be followed.

[4] Diets should always be formulated to provide required intake of amino acid. Concentration of crude protein in diet will vary with raw material used. Crude protein value provided is an estimated typical value only.

[5] Calcium and available phosphorus requirements are determined by flock age. When production remains higher and diets are fed for longer than ages shown, it is recommended to increase to calcium and phosphorus concentrations of next feeding phase.

[6] Calcium carbonate particle size recommendation varies throughout lay. Refer to Calcium Particle Size Table. Dietary calcium levels may need to be adjusted based on limestone solubility.

[7] Where other phosphorus systems are used, diets should contain recommended minimum level of available phosphorus.

Vitamins and Trace Minerals

- As the vitamin / trace mineral premix is often found in fine feed particles, a minimum level of 0.5% added liquid oil / fat in meal diets binds small particles in feed.
- Manage feeders to allow birds to consume fine particles during mid-day.

ITEM [1,2,3,4]	IN 1000 KG COMPLETE DIET	
	Rearing Period	Laying Period
Vitamin A, IU	10,000,000	8,000,000
Vitamin D_3[5], IU	3,300,000	3,300,000
Vitamin E, g	25	20
Vitamin K (menadione), g	3.5	2.5
Thiamin (B_1), g	2.2	2.5
Riboflavin (B_2), g	6.6	5.5
Niacin (B_3)[6], g	40	30
Pantothenic acid (B_5), g	10	8
Pyridoxine (B_6), g	4.5	4
Biotin (B_7), mg	100	75
Folic acid (B_9), g	1	0.9
Cobalamine (B_{12}), mg	23	23
Choline[7], g	110	110
Manganese[8], g	90	90
Zinc[8], g	85	80
Iron[8], g	30	40
Copper[8], g	15	8
Iodine, g	1.5	1.2
Selenium[8], g	0.25	0.22

[1] Minimum recommendations for rearing and laying periods. Local regulations may limit dietary content of individual vitamins or minerals.

[2] Store premixes according to supplier's recommendations and observe 'use by' dates to ensure vitamin activity is maintained. Inclusion of antioxidant may improve premix stability.

[3] Vitamin and mineral recommendations vary according to activity.

[4] Where heat treatment is applied to diet, higher levels of vitamins may be required. Consult with vitamin supplier regarding stability through individual production processes.

[5] A proportion of Vitamin D_3 can be supplemented as 25-hydroxy D_3 according to supplier's recommendations and applicable limits.

[6] Higher levels of Niacin are recommended in alternative systems.

[7] Inclusion may require adjustment when other dietary sources are considered.

[8] Greater bioavailability and productivity may be possible with use of chelated mineral sources.

Feed Particle Size (Grist)

A sieve shaker separates a feed sample into categories based on particle size.

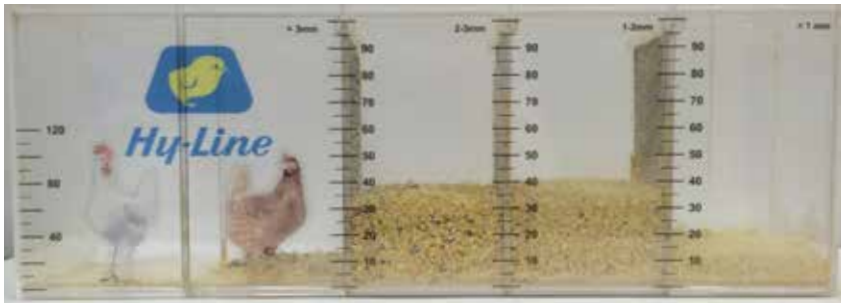
- Use on the farm to check feed particle size from the feed mill—sample taken on delivery or from feed bins.
- Use to assess the uniformity of feed particle size throughout the feeding system—samples are taken from various points.

Too many fine feed particles:

- Feed intake decreases because birds demonstrate a preference for a specific particle size
- Dust in house increases
- May lead to feather pecking

Too many coarse feed particles:

- Birds selectively eat large particles
- Risk of feed separation increases
- Separation of large particles is a particular problem with flat chain feeders.



Hy-Line Sieve Shaker

OPTIMAL FEED PARTICLE PROFILE

PARTICLE SIZE	STARTER	GROWER	DEVELOPER	PRODUCTION
< 1 mm	1–3 mm diameter, crumble feed should contain < 10% fine feed particles	< 15%	< 15%	< 15%
1–2 mm		45–60%	25–35%	20–30%
2–3 mm		10–25%	25–40%	30–40%
> 3 mm		–	5–10%	10–15%

For more information, see the "Feed Granulometry" technical update at www.hyline.com.

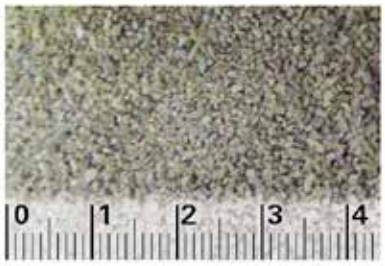
Best Practices

- A 3–4 hour gap between mid-day feedings allows time for birds to consume fine particles.
- Add a minimum of 0.5% liquid oil / fat in meal diets to incorporate and retain small particles in feed.
- Use larger particle size meal or crumble to increase intakes in hot climates.
- Use a crumble starter feed to promote good feed intake.
- Use a coarse mash feed for grower, developer, pre-lay and layer.

Calcium Particle Size

PARTICLE SIZE	STARTER, GROWER, DEVELOPER	PRE-LAY	WEEKS 17–37	WEEKS 38–48	WEEKS 49–62	WEEKS 63+
Fine (0–2 mm)	100%	50%	50%	45%	40%	35%
Coarse (2–4 mm)	–	50%	50%	55%	60%	65%

- The appropriate particle size depends on the solubility of limestone.
- Dietary calcium levels may need to be adjusted based on limestone solubility.
- Limestone dark in color is geologically older, containing more impurities (typically magnesium) and is generally lower in solubility and calcium availability.
- Oyster shell and other marine shells are good sources of soluble calcium.



Fine calcium (0–2 mm)

Coarse calcium (2–4 mm)

Photos courtesy of Longcliff Quarries Ltd.

Preventing Floor Eggs in Aviary/ Barn Systems

- Rear pullets in compatible aviary or barn systems.
- Train pullets to jump early, by giving access to the aviary system by 15 days of age. In floor operations, provide perches or elevated slats.
- Light should be evenly distributed within the house, avoiding areas of shadows. Use bulbs with good light dispersion to eliminate dark spots under feeders and in corners.
- Lighting in the house should keep the entrance to the nests well lit, but keep the inside of nests dark.
- Eliminate corners, where hens like to lay eggs.

NEST TRAINING

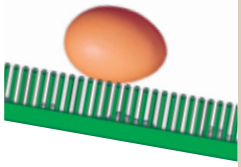
- In barn systems having automatic colony nests, open nest boxes and lift a few curtains to encourage nest exploration from the first day after transfer.
- Train females to use nests by frequent walks through the house in the morning for the first 8 weeks after birds are moved to the production house.
- While walking, move birds away from resting areas, out of corners and toward nests.
- In aviary systems, walk the birds in the evening to prevent birds from sleeping on the floor.
- It is important that all birds are within the aviary system or on the slats in barn systems before lights go off. Manually place floor birds in the system until they are trained to sleep in the system.
- If aviary has capacity to lock birds in at night, this should be done during the transition period to teach birds to lay in the nests. Do not open aviary doors until birds are consistently laying in the nest.
- During the first week of production, leave a few eggs in the nest to encourage females to use nests.
- Do not give birds access to the outside until they are consistently using the nests to lay eggs.
- Collect floor eggs frequently. Floor egg collection must be done more frequently at the beginning of lay. Birds will lay eggs on the floor if other eggs are present.
- Be sure all floor eggs are removed before lights go out at night.
- Place perches on slats in houses with a combination of slats and litter areas.

Open nest boxes and pull open a few curtains on nests after transfer for birds to explore and become accustomed to nests. Slats can be inclined to the nest opening to make access easier.

Nests

- Ensure there is sufficient nest space (6 birds per nest or 120 birds per m^2 in colony nests) and that hens are using all the nests. Partition the house if it appears only a few nests are being used.
- Make sure nests are easy to access. Any obstructions should be removed.
- Nests should be dark (< 0.5 lux), secluded, warm, and free of air drafts.
- Nests should have a perching area near the entrance to allow for examination and easy access by females.
- Feed lines should not be directly in front of nests.
- In aviary systems with nest boxes not on the top level, position water lines in front of nests and in lower levels.
- Do not place the water lines on levels above the nest boxes, as this will increase the risk of eggs being laid outside nests.
- Turn nest lights on 1–1.5 hours before house lights are turned on to attract females. Turn nest lights off 1 hour after house lights come on. Rope lights work well in this application.
- Discontinue nest light usage after 26 weeks of age.
- False walls or partitions (perpendicular to nests and spaced every 5–7 m) may reduce overcrowding in nests.
- Close nests at night. Do not allow birds to sleep in nests.
- Replace worn nest floor mats.

A good nest floor mat:



- *Provides comfort for nesting female*
- *Cushions egg to prevent damage*
- *Keeps egg clean*
- *Separates dirt and feathers from egg surfaces*
- *Allows egg to roll easily to egg belt*

HOUSE MANAGEMENT

- Use < 5 cm litter depth. Litter deeper than 5 cm may result in brooding behavior in hens. Remove excess litter if needed.
- Flocks housed in all-slat production houses should also be reared on slat or wire floors.
- Solid perches above water and feed lines are preferred.
- Feed and water lines should not block the movement of females to nests.
- Drinkers and perches in front of nests encourage bird movement toward nests.
- Schedule feed lines to run as soon as birds are awake and again after most eggs have been laid. Do not disturb the hens during peak egg laying time.
- Programming lights to encourage birds to sleep on the slatted area or within the aviary system will help prevent floor eggs.

Management of Aviary Flocks

Lighting for Aviary Flocks—Simulating Sunrise and Sunset

- 30 minutes before the scheduled time for house lights to turn off, turn off the lights at the floor level. 15 minutes later, turn lights off at the second level and finally the top level. This simulation of sunset within the house brings the birds up into the system to sleep on the upper roosting level.
- In the morning, this lighting sequence is reversed to bring birds down from the upper level to nests, feed and water.
- Rope lighting within the system works well for this application.

Stocking Density in Aviary Systems *(check local regulations concerning space requirements)*

- Stocking density from 6 to 9 birds/m^2 of useable floor space (excluding nests and perches).
- In aviary systems, the vertical living space of the house is increased, allowing for higher bird density. Consult with equipment manufacturers for appropriate stocking densities.
- If the porch (veranda) area is being considered as useable space for calculating bird density, then birds must have constant access to these areas.
- Overcrowded birds will struggle to properly access feed and water. In higher stocking densities, ensure proper feeder and drinker space guidelines are followed.

To avoid bird injuries, the vertical height of an aviary system should not exceed 2 meters, measured from floor to bottom of the manure belt of the highest level.

Management of Aviary Flocks *(continued)*

Aviary systems typically have the upper level as a resting/ sleeping area. Use a sequential lighting program to encourage birds up into the system at night.

Use ramps in an aviary system to facilitate bird movement between the floor and the system or between tiers within the system. Generally, a change in elevation greater than 90 cm a ramp will be needed to encourage bird movement and prevent injuries.

Ramps help facilitate bird movement between levels in an aviary system.

Management of Free Range Flocks

Bird Acclimatization

This is a critical period between rearing and the introduction of the laying house; it is vital to adjust the birds to their new surroundings, the environment and the critical factor of temperature.

Once the flock has settled into the laying house, start reducing the temperature (depending on time of year) to nearer the outside temperatures in order to acclimatize them for when the popholes open. This will help with stress and welfare of the flock at around 19 weeks.

Nutrition

Feeding birds in alternative systems is generally regarded as more difficult than feeding birds in colony systems, because of the additional competition between birds for feeder space, and because of greater fluctuations in house temperature. Birds in alternative systems generally have higher nutrient requirements than birds in intensive systems. Be aware of the potential pitfalls that can occur as a result of inadequate nutrition, and of the measures that may be required to prevent or rectify them. Some points to bear in mind are:

- Make sure that feeding space is adequate and that the distribution of feeders allows good access by the birds. Free range flocks have more competitive environments which could result in more aggression.
- Seasonal changes in temperature can exert a major influence on feed intake, particularly in poorly insulated houses. Feed intake by birds can change by as much as 30–40 g/bird/day from summer to winter. Increasing the quantity of feed supplied to the birds during cold weather, coupled with seasonal changes in the concentration of nutrients in the diets based on actual flock feed consumption, should be followed.
- The same feeding schedule used during the rearing period should be repeated during the laying period to train feeding behavior. This will ensure adequate feed intake during the peak period.

Pophole Management

- Popholes should be evenly distributed along the outside of the house and in sufficient numbers to prevent traffic jams as birds move in and out of the house. Preferably have popholes on two sides of the house.
- 1 pophole per 600 birds, with each pophole measuring 2 m long and 45 cm high. (Minimimum pophole size is 50 cm long and 45 cm high.)
- Close popholes during inclement weather.
- Begin opening popholes to give laying hens access to the outside after they are consistenly using the nests.
- On days with strong wind, only open the popholes on the leeward side of the house to prevent stirring of dust in the house.
- Introduce the birds to pasture gradually by increasing the amount of time the popholes are open. Make the transition over one week.
- Introducing birds to pasture too quickly can disturb their eating behavior and reduce their nutrient intake.
- Close popholes gradually as birds are returning to the house from outside. Close popholes at dusk or when artificial lights are to be turned off.
- Once the flock is given access to pasture, routinely open popholes to avoid bird stress.
- Areas around popholes typically have the heaviest contamination with internal parasite eggs. Tilling the ground in these areas will reduce this contamination.
- Slats or large rocks should be placed outside of pophole openings to prevent muddy areas.

Popholes are opened to give birds access to pasture as soon as possible after transfer.

This photo shows good maintaince of the area around popholes to keep the area dry and dirt out of the house.

Management of Free Range Flocks *(continued)*

Pasture Management

- The stocking density in pasture systems will be based on local regulations, soil type and diet.
- 2000–2500 layers per hectare of well-drained pasture.
- Rearing birds should have at least 1m^2 of outside space per bird (check local regulations regarding pasture space requirements).
- In some countries, the stocking density is determined by manure nutrient (phosphorus and nitrogen) management plans.
- Use of synthetic amino acid to reduce dietary nitrogen load and low phosphorus diets can allow higher stocking densities.
- Stocking density on well-drained pasture can be higher than on poorly drained clay soil.
- The pasture surrounding the laying house can be divided into paddocks, which the birds use for periods of 6–8 weeks before rotating to a new paddock. Rotation of paddocks provides time to regrow grass in bird-worn areas. Resting paddocks reduces the number of worm eggs in soil. If a rotational pasture system is used, stocking density can be higher.
- Birds tend to use pasture areas near the house more than areas away from the house. Care should be provided to spread birds over all usable pasture areas.
- Pastures can be maintained in good condition by the judicious use of chain harrows. Harrowing breaks up the soil, restores soil structure and improves drainage. Harrowing the soil kills worm eggs by exposing them to sunlight.
- Use more clover with grass in bird-worn areas around popholes and close to the house. Clover is durable against trampling by birds.
- Placing shelters in the pasture area encourages birds to move further from the house and utilize more of the pasture area. Shelters also provide shade and protection from rain and wind. Shelters should provide 8m^2 of cover per 1000 birds.
- Pasture shelters, when used as the only housing, should be able to shelter all the birds at one time, and provide feed and water.
- Trees, shrubs and shelters in the pasture area provide cover for birds to feel safe as they move away from the house. Chickens are naturally fearful of exposed areas.
- Between flocks, revegetate the pastures with emphasis on heavily used areas near the house and around popholes.
- Bird pastures can be dual purposed as orchards, woodlands and for livestock grazing.
- Pasture enrichments like fallen trees for perching and covered sand boxes for dust bathing should be considered.
- Some plants are poisonous to birds (i.e. hemlock, monkshood, privet, yew, nightshade, horseradish).

Exposure to Pasture:
(check local regulations for free range flocks)

- Hens that will have exposure to pasture during the lay period should be exposed to pasture during the pullet period.
- Birds in rear can be exposed to pasture when they are fully feathered.
- Birds can be encouraged to explore pasture by opening access doors after the peak laying time and walking the house to drive birds onto the pasture.
- Gradually introduce birds to pasture after they are effectively using the nest boxes. During the nest training period, hens can be let outside after the peak egg laying period.

Pastures should be well drained, not allowing standing water after a rain.

Outside shelters and natural vegetation encourage birds to use more of the available pasture area.

Management of Free Range Flocks *(continued)*

Predators

Free range layers are attractive to predators. There are several types of predators—from mammals (badgers, dogs, foxes, coyotes) to large reptiles (iguanas, snakes) and raptors (hawks, owls). Predators can cause injury and death. Predators will often kill or injure large numbers of birds—far more than they are able to consume. Predator attacks on the birds cause panic and hysteria in the flock. This can lead to piling (smothering) and trigger outbreaks of feather pecking.

Tips for Dealing with Predators

- Permanent fencing should be at least 1.83 m (6 ft) in height, with a 30 cm overhang to the outside to prevent predators from climbing over. The fence mesh should be small enough to exclude predators.
- Bury fencing 0.25 m (0.82 ft) into to the ground to prevent predators from digging under the fence.
- Overhead netting can be used if possible to prevent wild bird predators from attacking, and prevents contact with wild birds.
- Keep pastures mowed to keep predators from approaching the birds unaware.
- Flexible electrified fencing will generally provide satisfactory levels of protection against most predators.
- Old CDs or other reflective materials can be hung in paddocks to deter birds of prey.
- Use live traps outside the fence when predators are seen.
- Two electric wires should be used on the fence: one in the middle of the fence and the other just off the ground.
- Electric deterrent wires should be 25 cm above the ground and 0.6 m (1 ft) away from the permanent fence. A non-charged grounding wire placed between the ground and the electrified deterrent wire will help direct predators into the electrified wire.
- Check connections between the sections of fence and the transformer.
- The fencing and power unit must be well maintained in order to continue to work effectively.
- Grass underneath the fence must be kept cut to prevent shorting, and regular checks should be made on the connections between sections of fence and the transformer.
- Placing alpacas or llamas in the pasture can help deter predators, particularly foxes.

Foxes are frequent visitors to free range flocks.

Birds of prey will attack birds exposed in open pastures.

Snakes and reptiles are potential predators.

Wild and domestic dogs like chicken.

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Litter Management

Litter is used in a poultry house to dilute manure, absorb moisture and provide bird welfare, like the opportunity to dust bathe. A number of substrates are used as litter in poultry houses. Birds can express foraging and scratching behaviors on litter. The ideal litter should be absorbent, non-caking, non-toxic and resist mold growth. It should have high carbon levels to make it easily compostable. Use 5 cm of litter in laying houses. The key aspect of litter management is moisture control. Litter moisture above 30% can result in excessive ammonia in the house and allow the growth of pathogenic microorganisms.

Common litter types:

- Sand or gravel up to 8 mm granule size
- Wood shavings
- Wheat, spelt, rye straw
- Bark mulch
- Coarse wood chips
- Rice hulls

Litter selection is a balance of animal welfare, costs and egg sanitation. Each litter substrate has benefits and weakness to its use. It is important to expose the flock to litter during the pullet period. Birds exposed to litter at an early age (first 2 weeks of life) have less incidence of pecking behavior.

Keys to Maintaining Dry Litter

- Use a good litter material with high moisture absorbency.
- Maintain sufficient minimum ventilation rate in the house.
- Maintain leak-free water systems, replace leaking nipples and maintain proper water level in bell drinkers.
- Maintain proper drinker height and water pressure to prevent water spillage.
- Ensure good drainage of rain water away from the house.
- Remove caked litter frequently and replace with clean dry litter.
- Occasionally rake the litter to keep it friable and prevent caking. Encourage the birds to break up litter by placing small amounts of whole grain into litter.
- Remove extra litter to prevent floor eggs and maintain good air quality (less dust).

Grit

Grit is given to the flock to increase development of the crop and gizzard. Grit improves gizzard function to grind up ingested forage material and increases the digestibility of nutrients in the feed. There are two types of grit: soluble and insoluble.

- ***Soluble grit***—Soluble grit is added to every poultry diet in the form of limestone or oyster shell. Other marine shells can be used as soluble grit as well. To ensure proper shell formation and to reduce the risk of soft bones, soluble grit should be added to the diet at Hy-Line recommended levels.
- ***Insoluble grit***—Insoluble or flint grit is an indigestible stone that is either added to the diet or picked up while foraging. Pastured birds should receive grit to help them break down grasses, seeds and insects they consume.

Sand

Advantages:

- Reduces bacterial growth in the house compared to organic litter substrates.
- Lower surface temperature.
- Allows for dust bathing behavior.

Disadvantages:

- Sand is destructive to machinery.
- Sand recycling system may need to be purchased.
- Difficult to remove from the house and clean.
- More attention to floor temperature is needed.

Wood Shavings

Wood shavings should be made from soft wood trees. Shavings from hardwood may splinter, injuring the bird. (Sawdust as litter is less absorbent than wood shavings and tends to cake when wet.)

Advantage:

- A common litter material with good moisture absorbancy that is compostible.

Disadvantage:

- May increase incidence of feather pecking.

Straw

Straw from barley, Bermuda grass, flax, oat, wheat or rye can be used. Wheat straw is the most common. Straw should be chopped to 2.5 cm (1 in) or less.

Advantage:

- Absorbs more moisture than wood shavings.

Disadvantages:

- Incidence of caking is higher in straw compared to wood shavings or bark. This caking can cause foot pad lesions.
- Use of straw may increase incidence of feather pecking.

Bark Mulch or Wood Chips

Similar to wood shavings.

Advantage:

- Good moisture holding capacity.

Disadvantages:

- Particles more than 2.5 cm (1 in) in size lead to excessive caking.
- Excessive moisture can lead to mold problems.

AGE	PARTICLE SIZE OF GRIT	AMOUNT
< 3 Weeks	0.2 mm	1 g/bird in feed
6–11 Weeks	3–5 mm	2 g in feed
11–16 Weeks	5–6 mm	4 g in feed or separate feeders
Layers	6–8 mm	7 g/week

Feather Pecking

Birds have a social hierarchy called the pecking order. Some pecking is normal behavior to establish a stable social structure. Birds also spend a significant portion of the day foraging for food. Environments that are not suitable for the expression of these normal behaviors can lead to excessive feather pecking, and in extreme cases, cannibalism of other birds.

- Nutritional deficiencies can lead to feather pecking. A well-balanced diet based on Hy-Line recommendations will ensure dietary needs are met. Low protein and amino acid imbalance, particularly methionine, can cause feather pecking. Similiarly, low salt and calcium in feed can create cravings for these nutrients and result in more pecking behavior.
- Overcrowding the bird's floor, feeder, water and nest space can cause increased feather pecking.
- Loud noises cause stress, which leads to piling or feather pecking. Maintain equipment and check belts regularly to ensure proper function.
- High light intensity or sudden changes in the lighting program can cause piling. Flickering of the lights for any reason, such as a generator test, can cause piling as well.
- Litter substrates, such as fine-particle wood shavings or sawdust, may lead to increased incidence of feather pecking.
- Low fiber, fine textured or pelleted feed reduces the bird's feeding time and might encourage more feather pecking.
- Sudden changes in feed ingredients or feed particle size can increase pecking behavior.
- Large flock sizes have a less stabile social structure and are more likely to have excessive feather pecking.
- Pecking around the preen gland (near the tail) may indicate low salt in the diet or, in pullets 3–6 weeks of age, might be an indication of infectious bursal disease.
- Poor beak trimming can lead to pecking injuries.
- The use of nipple drinkers may reduce feather pecking.

Tips for Preventing Excessive Feather Pecking Behavior

Prevention measures taken during the rearing and early laying periods are more effective than in older flocks already exhibiting excessive feather pecking behavior.

- Match rearing and laying house environments as closely as possible. Provide plenty of perch space in both.
- Provide the recommended levels of light intensity in the house. In flocks exhibiting excessive feather pecking behavior, reduce light intensity to try to calm the flock.
- Check the diet adequacy, paying particular attention to energy, protein, sulfur-containing amino acids, salt and calcium.
- Reduce bird density, if possible. Reduce bird group size with the use of partitions.
- Minimize heat stress during the summer months. For more information, see the "Understanding Heat Stress in Layers" technical update at www.hyline.com.
- Enrich the house environment by adding bales of alfalfa on the floor, or add attractions like hanging string, plastic bottles or other toys to occupy birds' attention.
- Encourage more foraging behavior in barn systems by adding small amounts of grain into the litter in the afternoon.
- Add additional perches to provide more safe resting areas.
- Quickly remove injured and dead birds from the flock. Remove any birds displaying aggressive pecking and cannabalistic behavior.
- Keep houses in good repair, eliminating loose wires, sharp edges and areas where birds can be caught.
- Ensure that nests are dark (< 0.5 lux) and safe for hens to lay eggs without intrusion by other birds. Many pecking injuries to the vent occur in the nest when the vent is temporarily protruded after laying an egg.

Piling and Smothering

- Birds may pile without a discernable cause. Identifying time periods when birds tend to gather or pile can provide important clues to identify the reason for piling. Walking the house during these times may prevent piling and smothering.
- Panic in the flock, caused by predator attacks or heavy rodent populations, can result in piling.
- Hot areas in the house environment can cause piling.
- Sunlight shining directly into the house creating bright spots on the floor can cause birds to pile.
- Round off corners to prevent birds from congregating there.
- Install partitions to reduce piling in some nest boxes.
- Hens tend to gather together naturally during resting and sleeping, or when frightened. When these behaviors become exaggerated, piling/smothering can occur.
- Playing music in the house may keep birds calm and less reactive to sounds.
- An afternoon feeding before lights go out will spread birds out in the house.

Nest partitions placed perpendicular to the nests and spaced every 5–7 meters reduces overcrowding in nests.

Disease Control

A flock of pullets or layers can only perform up to its genetic potential when disease influence is minimized. The effects of disease can vary from a subclinical one on performance to serious levels of mortality. The diseases of economic importance differ widely between locations but, in every case, the challenge is to identify and control them.

Biosecurity

Biosecurity is the best method of avoiding disease. A good biosecurity program identifies and controls the most likely ways a disease can enter the farm.

- The most biosecure system is all-in/all-out, with complete cleaning and disinfection between flocks.
- Human and equipment movement onto the farm should be strictly controlled.
- Visitors to the farm should be limited to those essential for its operation.
- Visits should be documented in a logbook.
- All visitors and workers should shower at a central location before entering.
- Anyone who has visited another poultry facility within the last 48 hours should not be permitted access.
- Clean boots, clothing and head cover should be provided for everyone working on or visiting the farm.
- Clean footbaths containing approved disinfectants should be placed outside the entries to all poultry houses.
- If possible, avoid using outside crews or equipment for vaccination, moving and beak treatment.
- Ideally, workers should be limited to a single house.
- The number of flocks visited in one day should be limited and the progression should be from younger to older flocks and from healthy to sick flocks. After visiting a sick flock, no other flock should be visited.
- The removal of old flocks from the farm is a time when disease can be introduced, as trucks and crews have often visited other farms.
- A single-aged rearing farm using an all-in, all-out principle is best to prevent transmission of disease from older flocks to younger, susceptible flocks.
- Farm Assurance schemes usually require you to have a plan in place describing what biosecurity precautions you follow.
- All houses should be designed to prevent exposure of the flock to wild birds, insects and rodents.
- Quickly and properly dispose of dead chickens.

Rodents

Rodents are known carriers of many poultry diseases and they are the most common reason for re-contamination of a cleaned and disinfected poultry facility. They are also responsible for house-to-house spread of disease on a farm.

- The farm should be free of debris and tall grass that might provide cover for rodents.
- The perimeter of each house should have a 1 m wide area of crushed rock or concrete to prevent rodents burrowing under the house.
- Feed and eggs should be stored in rodent-proof areas.
- Bait stations should be placed throughout the house and maintained with fresh rodenticide.
- Houses and equipment should be designed to minimize the number of harborages, and pest-proofing features should be incorporated wherever possible. In the case of red mite, equipment such as feeders, nest boxes, perch frames, etc., should be designed to minimize the number of cracks and crevices as these are typical resting areas.
- Use products with different active ingredients on a cyclical basis to reduce the risk of resistance developing. This is particularly important in the case of red mite control. It is important not to assume that poor levels of control are due to product resistance—in most cases unsatisfactory performance is due to shortcomings of the operator rather than the product.

Disinfection

Cleaning and disinfection of the house between flocks reduces infection pressure for the next flock.

- Allow a minimum of 2 weeks down time between flocks.
- All feed, manure and litter should be removed from the house before cleaning.
- Thoroughly clean air inlets, fan housing, fan blades and fan louvres.
- Heating the house during washing improves the removal of organic matter.
- The house should be cleaned of organic matter wiht a high-pressure spray of warm water.
- Use foam/gel detergent to soak into organic matter and equipment.
- Wash the upper portion of the house before the pit.
- Use high-pressure warm water to rinse.
- After it is fully dry, apply foam/spray disinfectant followed by fumigation.
- Flush and sanitize water lines.
- Monitoring of poultry houses for presence of Salmonella, particularly *Salmonella enteritidis*, by routine environmental testing is recommended.
- Spills of feed and broken eggs, etc., should be cleaned up promptly; trash and clutter should not be allowed to accumulate either inside or outside the house.

Vertically Transmitted Diseases

- Some diseases are known to be transmitted from infected breeders to their progeny.
- Disease-free breeders are the first step in the control of these diseases at the commercial level.

- All breeders directly under Hy-Line's control are free of lymphoid leukosis, *Mycoplasma gallisepticum*, *Mycoplasma synoviae*, *Salmonella pullorum*, *Salmonella gallinarum*, *Salmonella enteritidis*, *Salmonella typhimurium* and other *Salmonella* species.
- Due to the possibility of horizontal transmission of any of these diseases, later generations may not remain free.
- It is the responsibility of the breeding stock and commercial flock owner to prevent horizontal transmission of these diseases and continue testing to be assured of a negative status.

Internal Parasites

(Check local regulations regarding treatment and prevention of internal parasites)

Internal parasites cause damage to the bird's intestinal tract and reduce the absorption of feed nutrients. This may result in a variety of problems including:

- Loss of shell strength, yolk, color and egg size.
- Poor body weight gain leading to unevenness or stunted birds. Affected birds may be dull and show pale combs.
- Increased cannibalism through vent pecking due to straining.
- Death, in very heavy infestations.
- Internal parasites can make birds more susceptible to disease or worsen an existing disease condition.
- Worm populations can increase rapidly in the flock. Consult with a veterinarian for an appropriate parasite control program.
- Rotation of pasture can be helpful in controlling internal parasites.
- Internal parasite infestations should be monitored by necropsy of cull birds and microscopic examination of feces for worm egg counts.

Ascarids (roundworms) is a common parasite of barn-reared and free range birds. Light infestations can rapidly become heavy infestations. Photo courtesy Dr. Yuko Sato, Iowa State University.

There are three important worms that may cause problems in free range birds:

Roundworms (*Ascaridia galli*)

- These are the largest and most common. They are white, up to 5 cm long and can be visible in droppings in heavy infestations.
- The roundworm life cycle is 21 days. Repeated treatments 21 days apart are needed to eliminate a heavy infestation.
- Ascarid eggs may be eaten by insects, which spread the infestation when eaten by free range birds.

Hairworms or Threadworms (Capillaria)

- These are much smaller (hair-like) and are barely visible with the naked eye but can cause significant damage even in only moderate infestations.
- Capillaria worms can infest the crop, esophagus and intestine.
- Eggs become infective in 4–6 weeks in feces.
- Some species of capillaria use the earthworm as an intermediate host to complete its life cycle.

Cecal worms (Heterakis) can carry the bacteria (Histomonas meleagridis) responsible for the disease called Blackhead. Photo courtesy Dr. Yuko Sato, Iowa State University.

Caecal worms (*Hetarakis gallinarum*)

- Hetarakis worms spend most of their time in the ceca, located at the lower end of the intestine. They cause no obvious harm in themselves, but can carry another parasite called Histomonas meleagridis, the cause of Blackhead.
- Effective control of cecal worms provides good protection against Blackhead. Heterakis eggs can survive three years in pastures.
- Birds become infected by picking up worm eggs from litter, soil and feces.
- The worm eggs need warm, moist conditions to develop outside the bird, which is why problems are frequently worse in the spring and summer, especially following a wet spring.
- Worm infestation in the flock can be identified by examination of feces and culled birds, or worm egg counts on pool fecal samples taken from the flock.
- Routine worm counts on droppings samples are recommended to monitor infection levels.
- Effective control is aimed at breaking the cycle of infection.
- Strategic use of feed or water administered deworming treatments (starting in the rearing phase and and continuing during the laying period) will control worms in the flock, when used in conjunction with limiting stock density on land, rotation of paddocks and providing good drainage.
- Removal of heavily contaminated soil around the house between flocks can reduce exposure to worm eggs.

Internal Parasites *(continued)*

(Check local regulations regarding treatment of internal parasites)

COCCIDIA

This parasitic infection of the intestines may lead to gut damage and, in severe infestations, death. More commonly, poor control of sub-clinical infection reduces feed conversion or leaves pullets with chronic, irreversible gut damage. Pullet flocks may be uneven or underweight at housing and not perform to their full potential in lay. Birds in aviary, barn and free range systems must have resistance to coccidiosis through the use of coccidiostats or by vaccination. Control of coccidia includes the following measures (check local regulations):

- Use ionophores or chemicals on a step-down dosing program will protect the bird from coccidiosis and allow stimulation of immunity in pullets.
- Live vaccine use is preferred to anti-coccidial drug treatments. Vaccines are administered in the hatchery or at chick placement in the rearing house.
- Control of flies and beetles, which are vectors of coccidia spread.
- Thorough cleaning and disinfection of houses reduces challenge pressure.
- Limit bird access to manure belts.
- Cocci vaccines require cycling by contact to manure; discuss this with the vaccine manufacturer.
- Dry, well drained pasture areas prevent the sporulation of oocytes. The eggs of coccidia (oocytes) sporulate and become infectious best when conditions are hot and humid.

Brachyspira

Brachyspira pilosicoli, previously known as *Serpulina* or *Treponema pilosicoli*, is an intestinal spirochaete that can be associated with inflammation of the large intestine in a broad range of mammals and birds.

- It has been associated with typhilitis (inflamed caecae), diarrhea (yellow and frothy), reduced egg production and egg shell soiling in chickens.
- Other related organisms can be present without causing adverse effects (*Brachyspira innocens*) or varying severity of adverse effects (*Brachyspira intermedia* and occasionally *Brachyspira hyodysenteriae*, the cause of swine dysentery).
- An abundance of frothy yellowish feces is often considered to be an indication of *Brachyspira* infection.
- As with other intestinal infections, correct nutrition, good water hygiene and avoidance of pooled water on range are important control measures.
- Laboratory diagnosis of infection is based on culture or PCR of pooled fecal samples or microscopic examination of ceca.
- Affected flocks can be given antibiotic treatment (check local relations concerning antibiotic use).

External Parasites

Red Mite (*Dermanyssus gallinae*)

Red mite is an important external parasite in laying flocks in all systems of management. Red mites are nocturnal blood feeders that hide during the day in dark, secluded areas in the house. Red mites multiply rapidly in warm summer months. Even light infestations create irritation, leading to poor performance and feed intake. More severe infestations can lead to some or all of the following:

- Flocks that are nervous with increased feather and vent pecking behavior.
- Feed intake may be depressed.
- Heavy mite infestation can depress egg production by up to 5%.
- Heavy infestations cause birds to become anaemic due to blood loss. These birds will be evident in the flock by their pale combs. If severely affected, mortality may increase.
- There may be loss of shell or yolk color.
- Increase soiling of eggshells with mite feces, which may lead to downgrading of eggs.
- There may be an increase in floor eggs, as birds will be reluctant to use infested nests.
- Egg collectors may experience skin irritation from red mites.

Red mite (Dermanyssus gallinae).

Controlling Red Mite

- Breaking the cycle of re-infection when the house is empty is the most effective approach.
- Treat the house between flocks, immediately after the birds are removed from the house while the red mites are still active.
- Use approved and effective products that have been properly applied, to reach into all crevices on equipment, walls, slats and nest boxes.
- Use a fan nozzle to produce a flat spray.
- Do not mix pesticides with disinfectants, unless recommended by the manufacturer.
- Red mites can live off a host without feeding for up to 6 months. Houses may require multiple treatments to eliminate infestation. Filling cracks or holes in the house or equipment will limit potential red mite areas in the house.
- Apply treatments at night when red mites are most effective.
- Rotate pesticide products to avoid mites developing resistance.
- Monitor the house and birds during the life of the flock and provide prompt treatment when red mites are observed.
- Treatment to break the red mite life cycle, which is 10 days. A three treatment program (on days 0, 10 and 20) is effective.

Red Mite/Northern Fowl Mite Treatments

(check local regulations regarding mite treatment)

- ***Pyrethroids***—A manmade chemical that causes paralysis and death in insects. As this is a common treatment, resistant varieties of mites exist throughout the world.
- ***Organophosphates, carbamates***—Interferes with acetylcholine transmission in insects; results in death of the mite. Normally ingested by the parasite, there are types ingested by the birds that are passed to the mite when birds are bitten.
- ***Vegetable oil***—Apply oil directly to the chicken to treat mites (impractical solution for large operations).
- ***Mineral-based products (both liquid sand dusts)***—Can be applied to the floor and walls of the house to prevent the spread of mites.
- ***Diatomaceous earth products***—These kill mites by absorbing the lipids from the exoskeleton and causing dehydration. Unlike pesticides, there is no development of resistance with these products.

Image Credit

Sakdoctor (username). "Dermanyssus gallinae mite." 21 June 2007. Online image. Wikimedia Commons. 18 September 2015. *https://upload.wikimedia.org/wikipedia/commons/0/0f/Dermanyssus_gallinae_mite.jpg*. Creative Commons license at *http://creativecommons.org/licenses/by-sa/2.5*.

External Parasites *(continued)*

Northern Fowl Mite (*Ornithonyssus sylviarum*)

Northern fowl mite is another common ectoparasite of chickens. These mites feed on blood and skin cells of the chicken and can cause significant losses of productivity and health with heavy infestations. Northern fowl mite is usually found on the downy feathers surround the cloaca (vent). They live on the bird for their entire life, but can survive off the bird for three weeks. Mites can be found on eggs, egg belts and on poultry workers when infestations are severe. There can be increased susceptability of some individual birds to infestations while other birds are unaffected. Infested birds can be identified by finding characteristic dark areas on the feathers around the vent made up of mites, dead mites, dried blood and skin cells.

Signs of Red Mite/Northern Fowl Mite Infestation

- Flocks that are nervous with increased feather and vent pecking behavior.
- Feed intake may be depressed.
- Heavy mite infestation can depress egg production by up to 5%.
- Heavy infestations cause birds to become anemic due to blood loss. These birds will be evident in the flock by their pale combs, and mortality may increase.
- There may be loss of shell or yolk color.
- Increased soiling of eggshells with mite feces may lead to downgrading of eggs.
- There may be an increase in floor eggs, as birds will be reluctant to use infested nests.
- Egg collectors may experience skin irritation from northern fowl mites.

Controlling Northern Fowl Mite

- Life cycle is 4–5 days, so outbreaks can occur rapidly.
- Pesticide treatments do not kill eggs, so repeat treatments are needed for good control.
- Sulfur treatment of the environment or through feed has been reported to have a good effect on controlling northern fowl mites.
- The pesticide must pentrate the feathers to be effective. Sprays should be delivered at 125 PSI and be directed to the vent area. Dust baths utilizing powder containing insecticide can be used. Individual birds can be dipped into room temperature pesticide solutions.

Northern fowl mites live on the feathers surrounding the vent area. Photo courtesy Dr. Bradley Mullens, University of California, Riverside.

Mites feed on blood and skin cells, causing irritation and loss of productivity. Photo courtesy Dr. Bradley Mullens, University of California, Riverside.

Mites can be found on eggs and egg belts. Photo courtesy Dr. Bradley Mullens, University of California, Riverside.

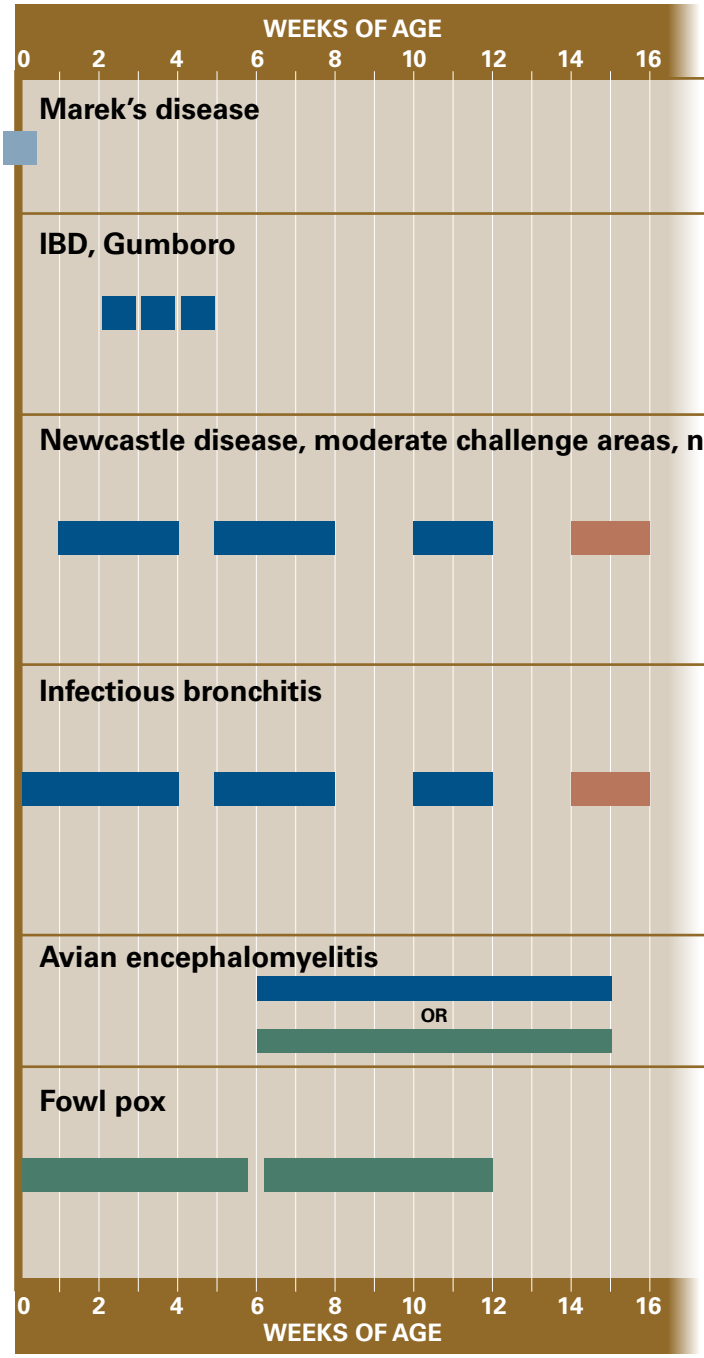
Vaccination Recommendations

Vaccination

Certain diseases are too widespread or difficult to eradicate and require a routine vaccination program. In general, all layer flocks should be vaccinated against Marek's disease, Newcastle disease (NDV), infectious bronchitis (IB), infectious bursal disease (IBD or Gumboro), avian encephalomyelitis (AE) and fowl pox. Other vaccinations are added to the program as local disease challenges dictate.

A single program cannot be recommended for all regions. Follow label instructions provided by the vaccine manufacturer. Use only approved vaccines. Consult with local veterinarians to determine the best vaccination program for your area.

BASIC COMMERCIAL LAYER VACCINE APPLICATIONS



Marek's disease

- All commercial layers should be vaccinated with Marek's vaccine in hatchery
- Rispens or Rispens / HVT vaccine preferred
- HVT / SB1 used in low challenge areas

IBD, Gumboro

- Given between days 15–18, 21–25, 28–32, IBD live vaccinations based on maternal antibody decline and field challenge
- Drinking water vaccination preferred
- HVT—IBD vector vaccine available for hatchery administration

Newcastle disease, moderate challenge areas, no velogenic Newcastle present

- 2–3 live vaccinations, allow 4–6 weeks between last live vaccination and injected inactivated vaccine

Infectious bronchitis

- Use Newcastle-bronchitis combination vaccines
- 2–3 live vaccinations using multiple IB serotypes build cross-protective immunity (if serotypes have been identified in the area)
- Last live vaccination should be administered as a spray
- Live boosting vaccinations every 30–60 days during production period may be needed to maintain high mucosal immunity

Avian encephalomyelitis

- Given once between 6 and 15 weeks to prevent egg drops
- Given via drinking water or often combined with fowl pox vaccine as a wing-web inoculation

Fowl pox

- 1 or 2 vaccinations
- Vaccination in birds less than 6 weeks should use highly attenuated fowl pox vaccine or pigeon pox
- Use pigeon pox with fowl pox to provide better cross-protection
- Most outbreaks due to poor vaccination technique
- For more information, see the "Fowl Pox in Layers" technical update at www.hyline.com

Live hatchery vaccines, given subcutaneous

Live vaccines, administered by drinking water, spray or eyedrop

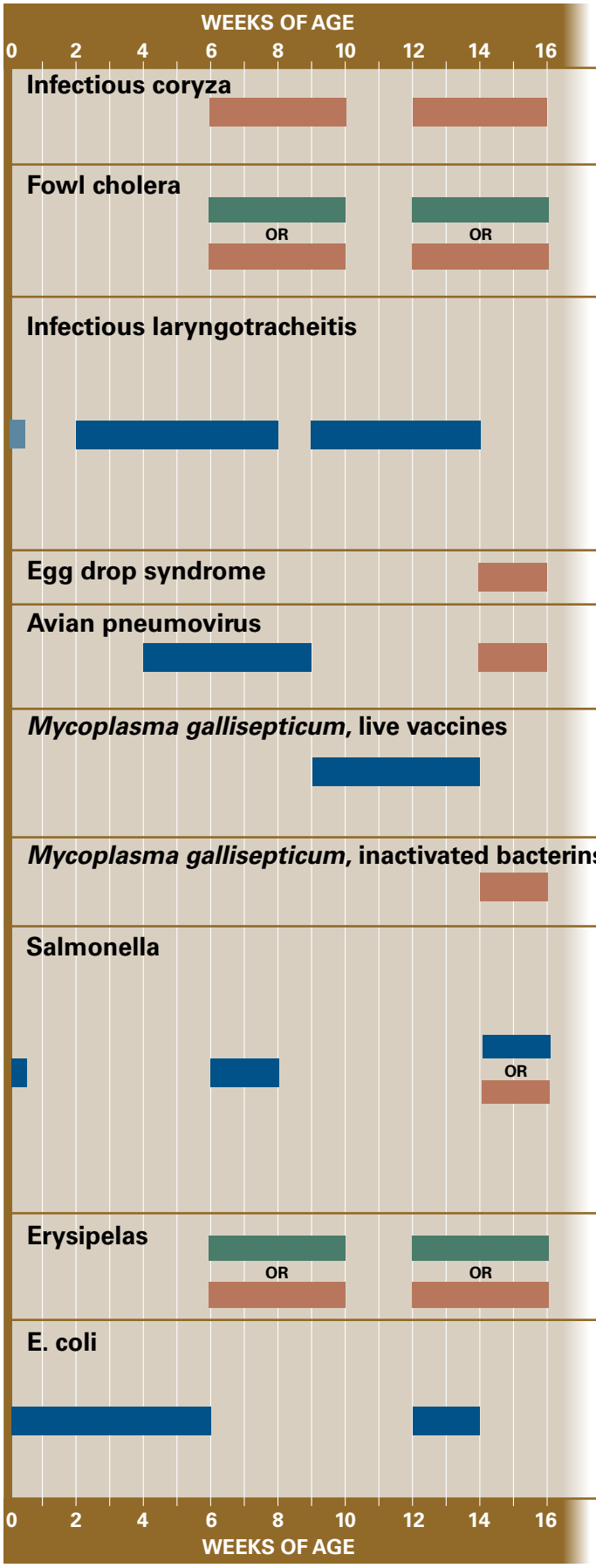
Live vaccines, administered via wing-web inoculation

Inactivated vaccines, injected via intramuscular or subcutaneous route

Vaccination Recommendations *(continued)*

OPTIONAL COMMERCIAL LAYER VACCINE APPLICATIONS

Use if these diseases are prevalent in the area. Follow label instructions provided by the vaccine manufacturer. Use only approved vaccines. Consult a local veterinarian for advice in designing an effective vaccination program for your farm.



Infectious coryza
- 2 vaccinations separated by 4 weeks
- Autogenous bacterins utilizing local isolates are sometimes used

Fowl cholera
- 2 vaccinations separated by 4 weeks
- Autogenous bacterins utilizing local isolates are sometimes used
- Live cholera vaccines such as M-9 or PM-1 are also used

Infectious laryngotracheitis
- 2 vaccinations
- Eye drop is the preferred method of vaccination
- Do not vaccinate within 7 days of another live respiratory vaccine
- Many ILT outbreaks are due to unwanted spread of ILT vaccine
- ILT-HVT vector vaccine available for hatchery administration
- ILT-pox vector vaccine available
- For more information, see the "Infectious Laryngotracheitis (ILT)" technical update at www.hyline.com

Egg drop syndrome
- 1 vaccination is highly effective

Avian pneumovirus
- Live and inactivated vaccines available
- Vaccination programs using both live and killed vaccines are most effective

***Mycoplasma gallisepticum*, live vaccines**
- Live vaccines can control economic impact of MG infection
- TS-11, 6 / 85 and F-strain vaccines available
- Use F-strain for stronger protection
- For more information, see the "MG Control in Commercial Layers" technical update at www.hyline.com

***Mycoplasma gallisepticum*, inactivated bacterins**
- Often MG bacterins are in combination with Newcastle and bronchitis

Salmonella
- Salmonella vaccination reduces colonization of internal organs and intestinal tract, reduces intestinal shedding into the environment
- 2 or 3 live vaccinations with modified Salmonella typhimurium or Salmonella enteritidis strains followed by an inactivated bacterin offers best protection
- Live vaccines provide good protection against strains within same serogroup and variable protection against strains of other serogroups
- Inactivated bacterins can provide targeted protection against a particular strain

Erysipelas
- 2 vaccinations separated by 4 weeks
- Increased risk if pasture was previously used by sheep or pigs
- Bacteria can persist in soil for years

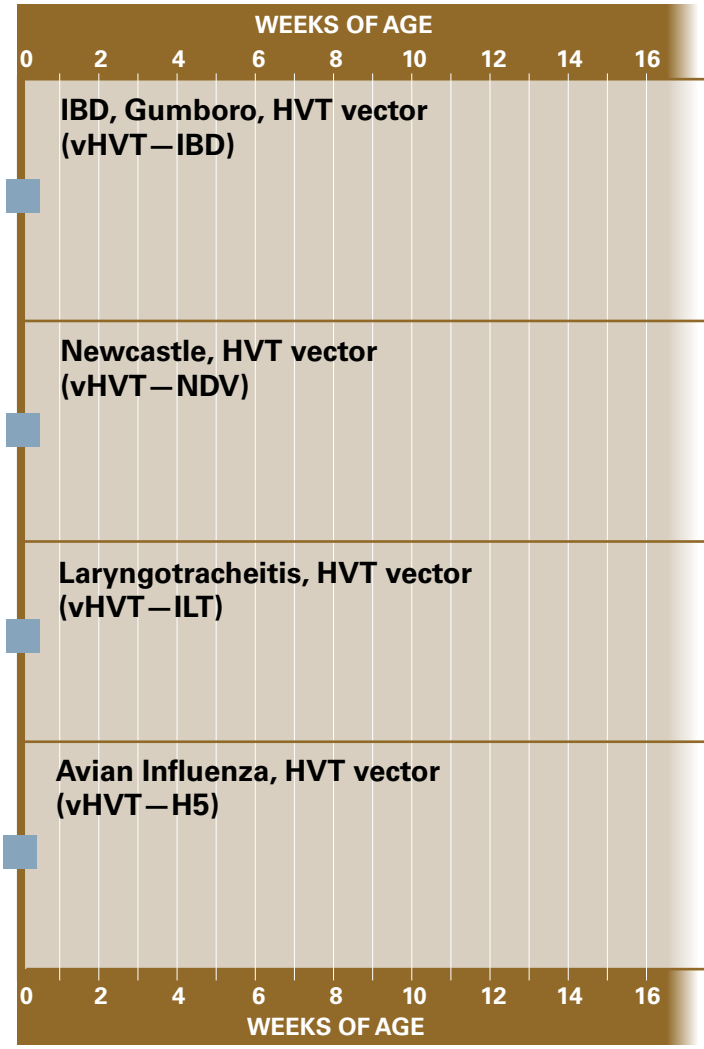
E. coli
- Live attenuated vaccine recommended for coarse spray application in the hatchery or in the rearing house the first few weeks
- Second vaccination at 12-14 weeks
- Can be combined with other live sprayed vaccinations
- For more information, see the "Colibacillosis in Layers" technical update at www.hyline.com

Vaccination Recommendations *(continued)*

RECOMBINANT HVT VACCINES

Vaccines using recombinant vector technology offer the convenience of hatchery administration with no adverse effects caused by some live field vaccinations. For the best Marek's disease protection, use Rispens vaccine in combination with recombinant HVT vaccine.

CAUTION: Do not use another HVT vaccine when using HVT-vectored vaccines.



IBD protective gene (VP2) inserted into non-essential region of HVT virus

- May replace the need for field vaccinations with live IBD vaccines
- No interference from maternal antibodies
- For more information, see the "Infectious Bursal Disease (IBD, Gumboro)" technical update at www.hyline.com

NDV protective genes (fusion protein and neuraminidase) inserted into non-essential region of HVT virus

- Reduces number of live field vaccinations
- Inactivated vaccine still needed for best long-term protection

ILT protective genes inserted into non-essential region of HVT virus

- May reduce need for live vaccination depending on field challenge
- For more information, see the "Infectious Laryngotracheitis (ILT)" technical update at www.hyline.com

Avian influenza H5 protective genes inserted into non-essential region of HVT virus

- Provides protection against any H5 influenza virus without the need for additional vaccinations
- Use of influenza vaccine is generally restricted to countries or regions where the disease is endemic
- Duration of protective immunity unclear

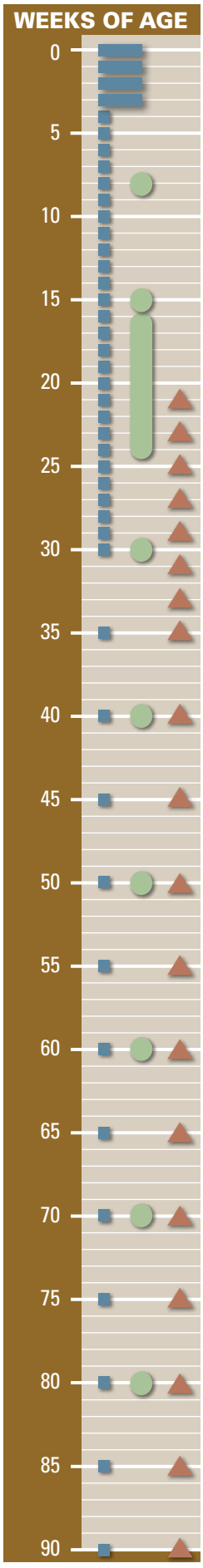
Live hatchery vaccines, given subcutaneous

Live vaccines, administered by drinking water, spray or eyedrop

Live vaccines, administered via wing-web inoculation

Inactivated vaccines, injected via intramuscular or subcutaneous route

Flock Monitoring



AGES OF BODY WEIGHT MEASUREMENTS

0–3 weeks

- Bulk weigh 10 boxes of 10 chicks.

4–29 weeks

- Weigh 60–100 birds individually every week.
- Calculate uniformity.

30–90 weeks

- Weigh 60–100 birds individually every 5 weeks.
- Calculate uniformity.

When handling birds for body weights, assess:

- Keel bone—straightness and firmness (see the "Understanding the Role of the Skeleton in Egg Production" technical update at www.hyline.com)
- Breast muscle score (see p. 9)
- Body fat
- External parasites
- Clinical symptoms of disease

AGES OF SERA COLLECTION

For more information, see the "Proper Collection and Handling of Diagnostic Samples" technical update at www.hyline.com.

Collect 10–20 sera samples per flock for titer determination.

8 weeks

- Assess early vaccination technique and disease exposure.

15 weeks

- Collect sera before transfer to lay house to assess possible change in disease exposure.
- It is common to not send to laboratory and freeze for future analysis in event of disease outbreak on lay farm.

16–24 weeks

- Collect sera at least 4 weeks after final inactivated vaccination to measure post-vaccination antibody response.
- It is useful to assess disease challenge and response to inactivated vaccinations after transfer to lay farm.

AGES TO MONITOR EGG WEIGHTS

Weigh 100 eggs from randomly selected nests. Monitor egg weights on a specific day of the week within the same 3-hour time frame.

Monitor worm egg counts in pooled fecal samples every month.

Bird Handling—BE GENTLE

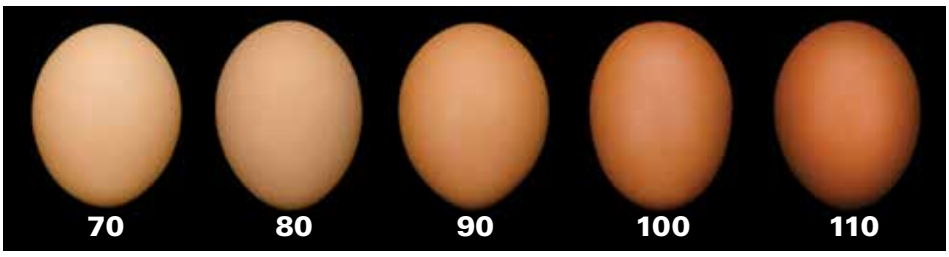
- *Proper handling of birds during body weight measurements, blood collection, selection, vaccination, and transfer will reduce bird stress and prevent injuries.*
- *Hold birds by both legs or both wings.*
- *Return birds to floor gently.*
- *Use experienced personnel that have been trained in proper procedures of bird handling.*
- *Continually observe personnel for proper handling.*

Egg Quality and Egg Size Distribution

EGG QUALITY			
AGE (weeks)	HAUGH UNITS	BREAKING STRENGTH	SHELL COLOR
20	97.8	4605	89
22	97.0	4590	89
24	96.0	4580	89
26	95.1	4570	88
28	94.2	4560	88
30	93.3	4540	88
32	92.2	4515	88
34	91.5	4490	88
36	90.6	4450	87
38	90.0	4425	87
40	89.3	4405	87
42	88.5	4375	87
44	87.8	4355	87
46	87.1	4320	87
48	86.4	4305	87
50	85.6	4280	86
52	85.0	4250	86
54	84.6	4225	86
56	84.0	4190	85
58	83.1	4170	85
60	82.6	4150	85
62	82.2	4130	84
64	81.9	4110	83
66	81.6	4095	83
68	81.5	4085	82
70	81.1	4075	81
72	81.0	4065	81
74	80.8	4055	80
76	80.5	4040	80
78	80.2	4020	80
80	80.1	3995	80
82	80.0	3985	79
84	79.9	3975	79
86	79.8	3965	79
88	79.7	3960	79
90	79.7	3955	79

EGG SIZE DISTRIBUTION—E.U. STANDARDS					
AGE (weeks)	AVERAGE EGG WEIGHT (g)	% VERY LARGE Over 73 g	% LARGE 63–73 g	% MEDIUM 53–63 g	% SMALL 43–53 g
20	51.2	0.0	0.0	21.7	78.3
22	54.2	0.0	0.0	69.9	30.1
24	56.6	0.0	0.3	93.9	5.9
26	58.5	0.0	2.5	96.6	0.8
28	60.2	0.0	11.2	88.7	0.1
30	60.9	0.0	18.1	81.9	0.0
32	61.3	0.0	23.9	76.0	0.0
34	61.7	0.0	29.4	70.6	0.0
36	61.9	0.0	32.3	67.7	0.0
38	62.1	0.0	35.9	64.0	0.0
40	62.3	0.0	39.0	61.0	0.0
42	62.6	0.0	43.9	56.1	0.0
44	62.9	0.0	48.5	51.5	0.0
46	63.0	0.0	50.0	50.0	0.0
48	63.2	0.0	52.8	47.1	0.0
50	63.4	0.0	55.5	44.5	0.0
52	63.5	0.1	56.5	43.5	0.0
54	63.5	0.1	56.5	43.4	0.0
56	63.6	0.1	57.3	42.6	0.0
58	63.6	0.2	57.3	42.5	0.0
60	63.7	0.3	58.2	41.5	0.0
62	63.8	0.4	59.0	40.6	0.0
64	63.9	0.6	59.7	39.8	0.0
66	64.0	0.9	60.3	38.9	0.0
68	64.1	1.1	60.4	38.4	0.0
70	64.2	1.6	60.4	38.0	0.0
72	64.3	1.9	60.8	37.3	0.0
74	64.4	2.6	60.7	36.7	0.0
76	64.5	3.1	60.7	36.2	0.0
78	64.6	4.0	60.4	35.6	0.0
80	64.8	5.1	59.9	35.1	0.0
82	64.8	5.9	59.1	34.9	0.0
84	64.9	6.9	58.3	34.8	0.0
86	64.9	8.1	57.1	34.8	0.0
88	65.0	9.2	56.3	34.4	0.0
90	65.0	10.3	55.2	34.4	0.0

SHELL COLOR SCORES

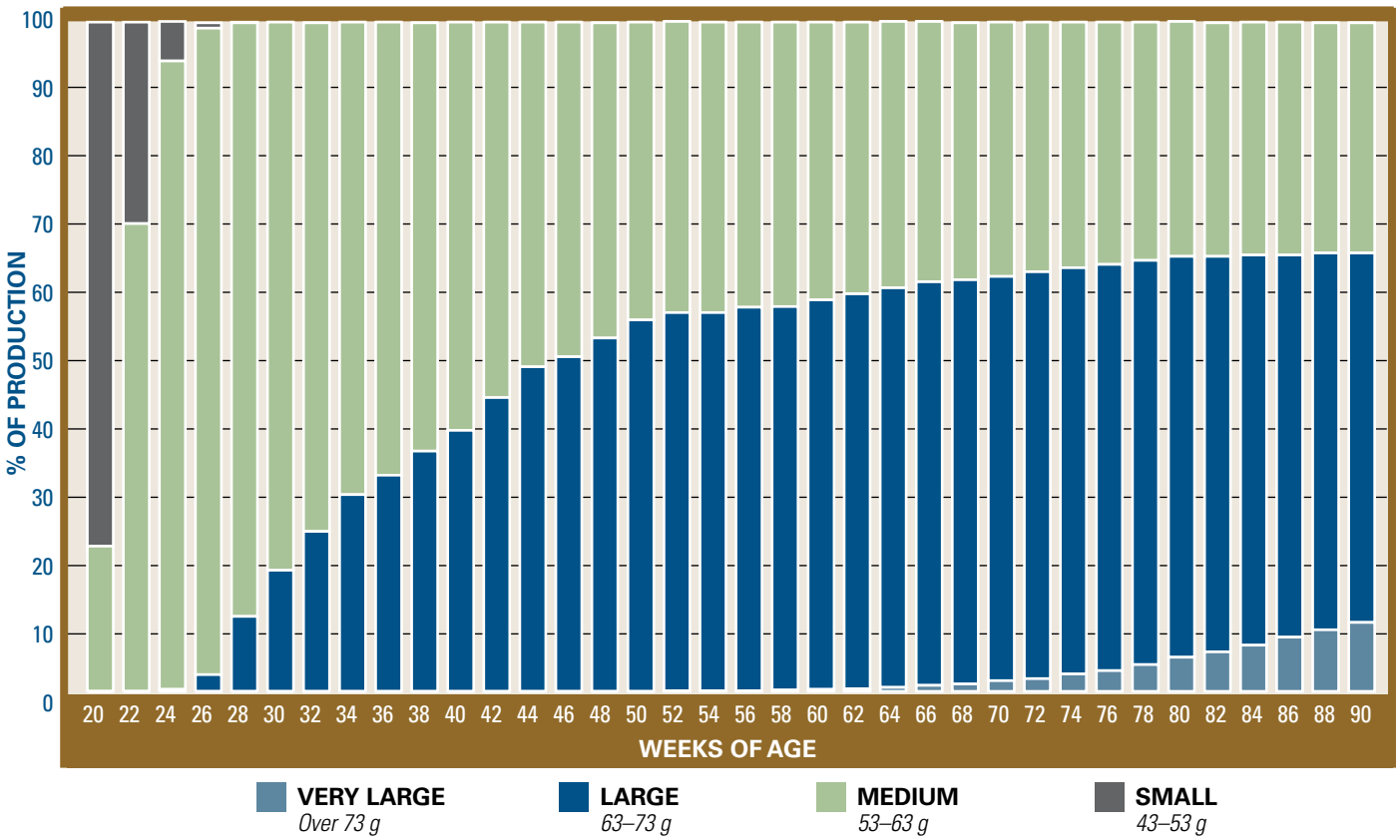


Egg shell color is a genetically determined trait but environmental factors can reduce color. Certain diseases which infect the shell gland, such as infectious bronchitis and Egg Drop Syndrome are known to reduce shell color. Stress can result in the egg being held longer in the shell gland, resulting in white calcium carbonate deposition on the egg shell surface. Shell color is gradually reduced with advancing age.

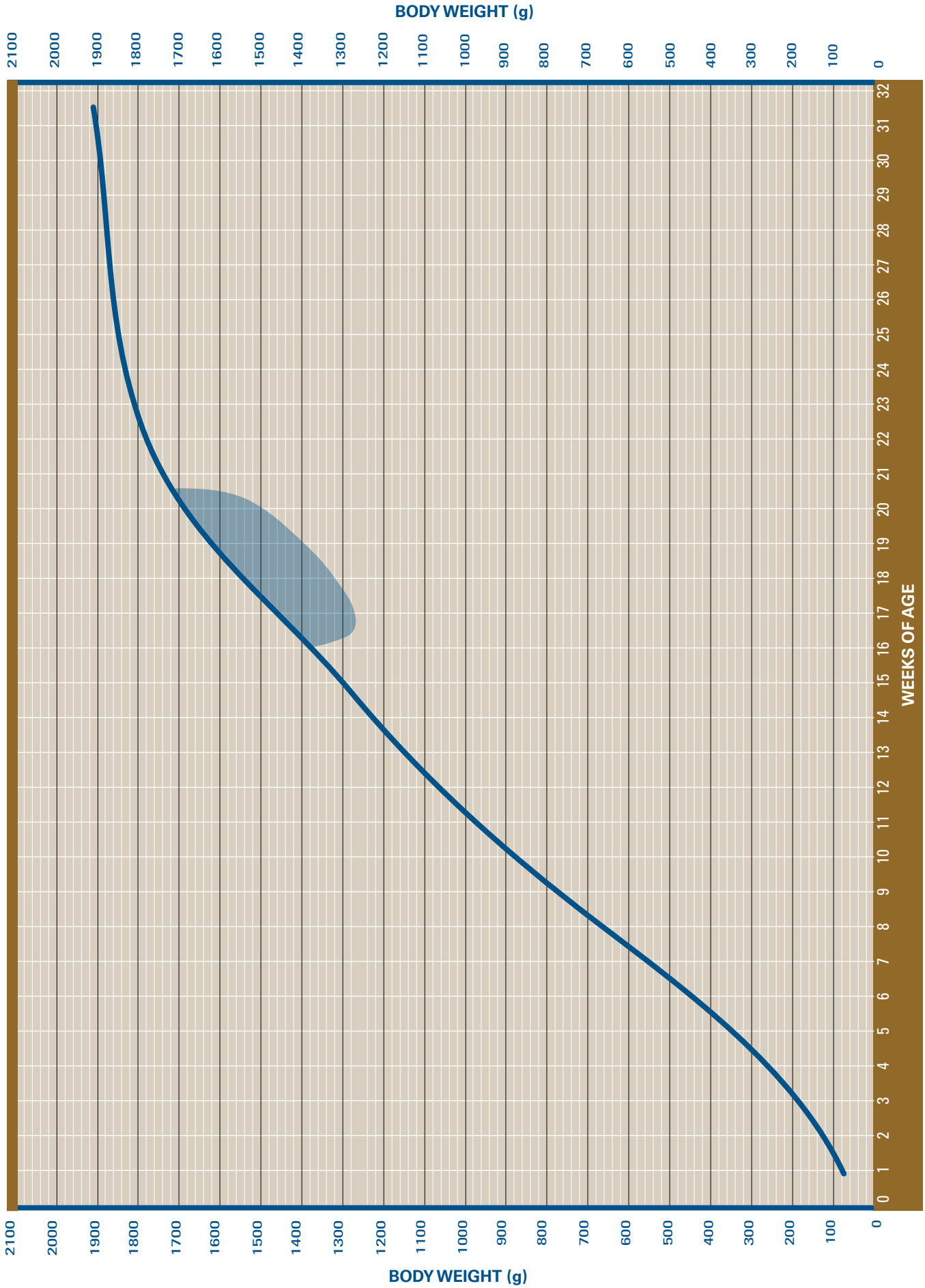
For more information on egg quality, see the "The Science of Egg Quality" technical update at www.hyline.com.

Egg Size Distribution *(continued)*

EGG SIZE DISTRIBUTION—E.U. STANDARDS

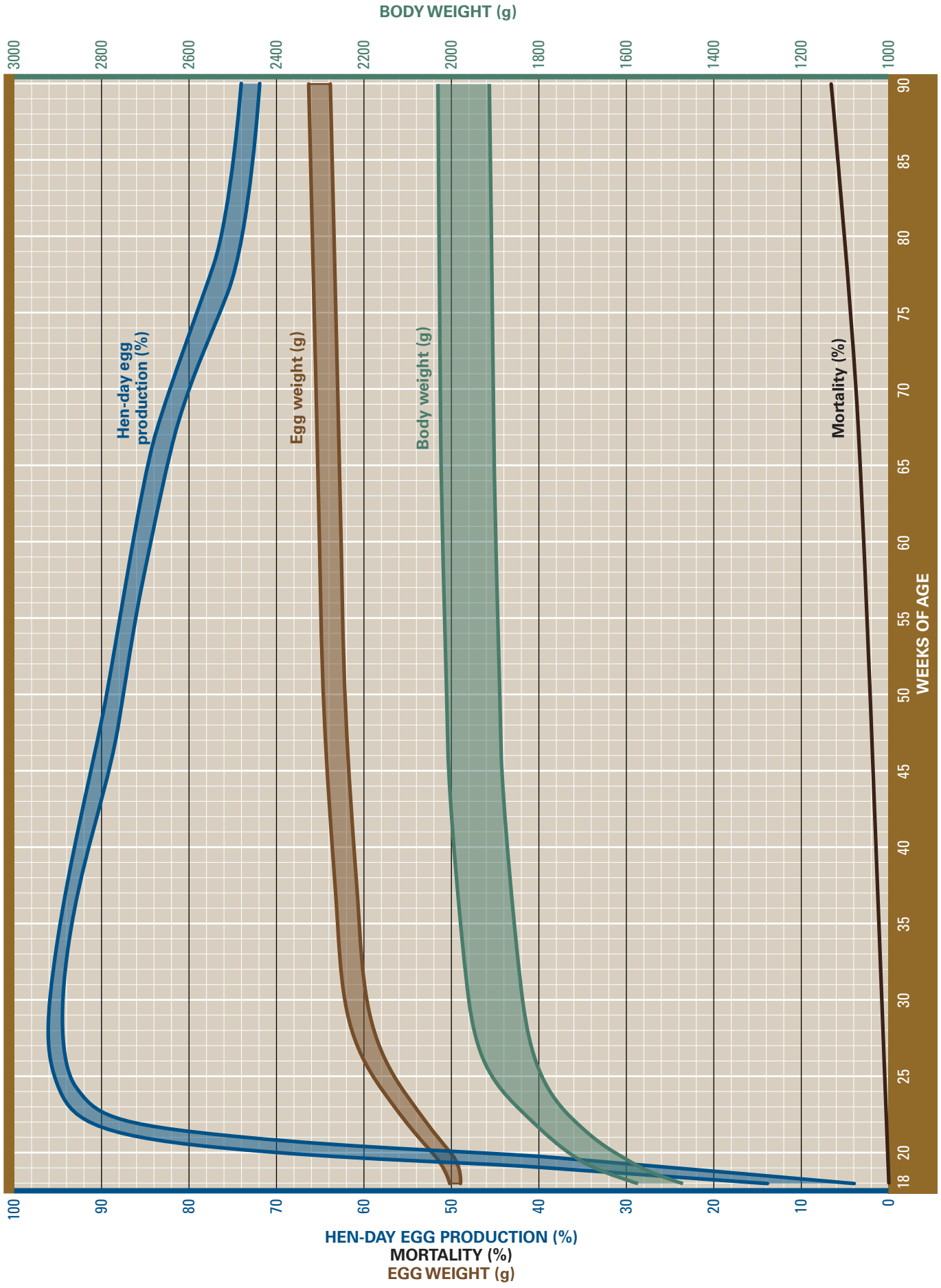


Growth Curve



* Blue shaded area represents potential body weight loss during transfer.

Performance Graph



Feed Ingredient Table 1

INGREDIENT (as-fed basis)	DRY MATTER (%)	CRUDE PROTEIN (%)	FAT–ether extract (%)	CRUDE FIBER (%)	CALCIUM (%)	PHOSPHORUS total (%)	PHOSPHORUS available (%)	SODIUM (%)	CHLORIDE (%)	POTASSIUM (%)	SULFUR (%)	ME (kcal/lb)	ME (kcal/kg)	ME (MJ/kg)	LINOLEIC ACID (%)	CHOLINE (mg/kg)
Barley, grain	89.0	11.5	1.9	5.0	0.08	0.42	0.15	0.03	0.14	0.56	0.15	1250	2750	11.51	1.1	1027
Beans, broad (vicia faba)	89.0	25.7	1.4	8.2	0.14	0.54	0.20	0.08	0.04	1.20	–	1100	2420	10.13	0.9	1670
Calcium carbonate (38%Ca)	99.5	–	–	–	38.00	–	–	0.06	–	0.06	–	–	–	–	–	–
Canola meal (38%)	91.0	38.0	3.8	11.1	0.68	1.20	0.40	–	–	1.29	1.00	960	2110	8.83	0.6	6700
Canola oil	99.0	–	99.0	–	–	–	–	–	–	–	–	4000	8820	36.92	20.50	–
Corn, yellow, grain	86.0	7.5	3.5	1.9	0.01	0.28	0.12	0.02	0.04	0.33	0.08	1530	3373	14.12	1.9	1100
Corn gluten feed	88.0	21.0	2.0	10.0	0.20	0.90	0.22	0.15	0.22	1.30	0.16	795	1750	7.32	1.6	2420
Corn gluten meal (60%)	90.0	60.0	2.0	2.5	0.02	0.50	0.18	0.03	0.05	0.45	0.50	1700	3740	15.65	1.8	2200
Distillers dried grains, corn	92.0	27.0	9.0	13.0	0.09	0.41	0.17	0.25	0.07	0.16	0.43	910	2000	8.37	5.05	1850
Cottonseed meal (41%), mech. Extd	91.0	41.0	3.9	12.6	0.17	0.97	0.32	0.04	0.04	1.22	0.40	955	2100	8.79	0.8	2807
Cottonseed meal (41%), direct solv.	90.0	41.0	2.1	11.3	0.16	1.00	0.32	0.04	0.04	1.20	0.42	915	2010	8.41	0.4	2706
Dicalcium phosphate (18.5% P)	99.5	–	–	–	22.00	18.50	18.50	0.08	–	0.07	–	–	–	–	–	–
DL-Methionine	99.5	58.1	–	–	–	–	–	–	–	–	–	2277	5020	21.01	–	–
Fat, animal	99.0	–	98.0	–	–	–	–	–	–	–	–	3600	7920	33.15	–	–
Fat, animal-vegetable blend	98.0	–	92.0	–	–	–	–	–	–	–	–	3800	8379	35.07	30.00	–
Fat, vegetable	99.0	–	99.0	–	–	–	–	–	–	–	–	4000	8800	36.83	40.00	–
Fish meal, anchovy, Peruvian	91.0	65.0	10.0	1.0	4.00	2.85	2.85	0.88	0.60	0.90	0.54	1280	2820	11.80	0.1	5100
Fish meal, white	91.0	61.0	4.0	1.0	7.00	3.50	3.50	0.97	0.50	1.10	0.22	1180	2600	10.88	0.1	4050
Flaxseed	92.0	22.0	34.0	6.5	0.25	0.50	–	0.08	–	1.50	–	1795	3957	16.56	54.00	3150
Linseed meal flax (expeller)	90.0	32.0	3.5	9.5	0.40	0.80	–	0.11	–	1.24	0.39	700	1540	6.45	0.5	1672
Linseed meal flax (solvent)	88.0	33.0	0.5	9.5	0.35	0.75	–	0.14	–	1.38	0.39	635	1400	5.86	0.1	1760
L-Lysine·HCl	99.5	93.4	–	–	–	–	–	–	–	–	–	1868	4120	17.24	–	–
L-Threonine	99.5	72.4	–	–	–	–	–	–	–	–	–	1619	3570	14.94	–	–
L-Tryptophan	95.0	84.0	–	–	–	–	–	–	–	–	–	2653	5850	24.49	–	–
Mono-dicalcium phosphate (21% P)	99.5	–	–	–	16.00	21.00	–	0.05	–	0.06	–	–	–	–	–	–
Oats, grain	90.0	11.0	4.0	10.5	0.10	0.35	0.14	0.07	0.12	0.37	0.21	1160	2550	10.67	2.4	1070
Peanut meal, solvent	90.0	47.0	2.5	8.4	0.08	0.57	0.18	0.07	0.03	1.22	0.30	1217	2677	11.20	0.5	1948
Rice bran, unextracted	91.0	13.5	5.9	13.0	0.10	1.70	0.24	0.10	0.07	1.35	0.18	925	2040	8.54	5.2	1390
Rice, grain, rough	89.0	7.3	1.7	10.0	0.04	0.26	0.09	0.04	0.06	0.34	0.10	1335	2940	12.31	0.83	1014
Safflower seed meal, expeller	91.0	20.0	6.6	32.2	0.23	0.61	0.20	0.05	0.16	0.72	0.10	525	1160	4.86	–	800
Salt, NaCl	99.6	–	–	–	–	–	–	39.34	60.66	–	–	–	–	–	–	–
Sodium bicarbonate, $NaHCO_3$	99.0	–	–	–	–	–	–	27.38	–	–	–	–	–	–	–	–
Sorghum, milo, grain	89.0	11.0	2.8	2.0	0.04	0.29	0.10	0.03	0.09	0.34	0.09	1505	3310	13.85	1.3	678
Soybeans, full-fat, cooked	90.0	38.0	18.0	5.0	0.25	0.59	0.20	0.04	0.03	1.70	0.30	1520	3350	14.02	9.9	2420
Soybean meal, expeller	89.0	42.0	3.5	6.5	0.20	0.60	0.20	0.04	0.02	1.71	0.33	1100	2420	10.13	1.8	2673
Soybean meal, solvent	90.0	44.0	0.5	7.0	0.25	0.60	0.20	0.04	0.02	1.97	0.43	1020	2240	9.38	0.3	2743
Soybean meal dehulled, solvent	88.0	47.8	1.0	3.0	0.31	0.72	0.24	0.04	0.02	2.05	0.43	1115	2458	10.29	0.6	2850
Soybean oil	99.0	–	99.0	–	–	–	–	–	–	–	–	4000	8820	36.92	40.00	–
Sunflower meal, expeller	93.0	41.0	7.6	21.0	0.43	1.00	0.25	0.20	0.01	1.00	–	1050	2310	9.67	6.5	–
Sunflower meal, partially dehul, solv.	92.0	34.0	0.5	13.0	0.30	1.25	0.27	0.20	0.01	1.60	0.38	1025	2260	9.46	0.2	1909
Triticale	90.0	12.5	1.5	–	0.05	0.30	0.10	–	0.07	–	0.20	1430	3150	13.18	0.9	460
Wheat, hard grain	88.0	13.5	1.9	3.0	0.05	0.41	0.12	0.06	0.07	0.50	0.10	1440	3170	13.27	1.0	778
Wheat, soft grain	86.0	10.8	1.7	2.8	0.05	0.30	0.11	0.06	0.07	0.40	0.10	1460	3210	13.44	1.0	778
Wheat bran	89.0	14.8	4.0	10.0	0.14	1.17	0.38	0.06	0.14	1.20	0.22	590	1300	5.44	2.1	980
Wheat middlings	89.0	15.0	3.6	8.5	0.15	1.17	0.45	0.06	0.07	0.60	0.16	950	2090	8.75	1.9	1100

Nutrient recommendations are based on calculations using these energy and nutrient values (source: 2015 Feedstuffs Reference Issue and field data). Values provided are "typical" based on ingredient surveys. Nutrient values should be confirmed by analysis of the materials being used in order to maintain an accurate formulation matrix.

Feed Ingredient Table 2

INGREDIENT (as-fed basis)	CRUDE PROTEIN (%)	LYSINE (%)		METHIONINE (%)		CYSTINE (%)		THREONINE (%)		TRYPTOPHAN (%)		ARGININE (%)		ISOLEUCINE (%)		VALINE (%)	
		Total content	Digestible content	Total content	Digestible content	Total content	Digestible content	Total content	Digestible content	Total content	Digestible content	Total content	Digestible content	Total content	Digestible content	Total content	Digestible content
Barley	11.5	0.40	0.35	0.18	0.16	0.24	0.21	0.38	0.32	0.14	0.10	0.56	0.48	0.39	0.35	0.55	0.46
Beans, Field	25.7	1.61	1.37	0.18	0.13	0.30	0.20	0.88	0.69	0.22	0.15	2.27	1.97	1.02	0.74	1.15	0.83
Corn	7.5	0.23	0.21	0.16	0.15	0.17	0.15	0.27	0.23	0.06	0.05	0.36	0.34	0.25	0.24	0.35	0.32
Corn Gluten Feed	21.0	0.65	0.47	0.34	0.29	0.44	0.29	0.75	0.57	0.10	0.09	0.96	0.85	0.62	0.51	0.99	0.83
Corn Gluten Meal	60.0	0.99	0.75	1.43	1.26	1.03	0.80	2.00	1.58	0.32	0.21	1.88	1.62	2.39	2.05	2.71	2.30
Dist Dried Grains & Sol, Corn	27.0	0.76	0.57	0.53	0.43	0.50	0.38	1.01	0.72	0.22	0.17	1.16	0.85	0.99	0.83	1.31	1.06
Cottonseed Meal	41.0	1.63	1.06	0.58	0.42	0.65	0.48	1.27	0.86	0.51	0.40	4.67	4.11	1.25	0.89	1.75	1.29
DL-Methionine	58.1	–	–	99.00	99.00	–	–	–	–	–	–	–	–	–	–	–	–
Fish Meal (65%)	65.0	4.67	4.02	1.72	1.48	0.54	0.39	2.61	2.08	0.66	0.52	3.71	3.04	2.60	2.21	3.05	2.53
Fish Meal (61%)	61.0	4.24	3.65	1.57	1.35	0.50	0.36	2.39	1.92	0.60	0.47	3.45	2.83	2.39	2.03	2.82	2.34
Linseed Products	22.0	0.92	0.83	0.39	0.31	0.37	0.29	0.80	0.73	0.33	0.30	1.99	1.83	0.90	0.79	1.07	0.92
L-Lysine·HCl	93.4	78.80	78.80	–	–	–	–	–	–	–	–	–	–	–	–	–	–
L-Threonine	72.4	–	–	–	–	–	–	98.50	98.50	–	–	–	–	–	–	–	–
L-Tryptophan	84.0	–	–	–	–	–	–	–	–	98.00	98.00	–	–	–	–	–	–
Oats	11.0	0.44	0.39	0.18	0.15	0.31	0.26	0.37	0.31	0.15	0.12	0.72	0.67	0.40	0.35	0.54	0.48
Peanut Meal	47.0	1.50	1.14	0.49	0.42	0.59	0.47	1.20	1.02	0.46	0.40	5.19	4.72	1.50	1.34	1.82	1.62
Rapeseed Meal[1]	38.0	1.95	1.56	0.73	0.61	0.92	0.71	1.55	1.13	0.52	0.41	2.32	2.02	1.46	1.15	1.86	1.47
Rice	7.3	0.26	0.21	0.19	0.17	0.17	0.14	0.25	0.20	0.09	0.08	0.57	0.52	0.28	0.23	0.40	0.34
Rice Bran	13.5	0.61	0.45	0.26	0.20	0.27	0.19	0.50	0.34	0.17	0.13	1.05	0.90	0.46	0.35	0.71	0.53
Safflower Meal	20.0	0.59	0.49	0.30	0.26	0.32	0.25	0.62	0.45	0.19	0.15	1.66	1.40	0.70	0.56	1.00	0.81
Sorghum	11.0	0.25	0.23	0.19	0.17	0.19	0.15	0.35	0.29	0.12	0.11	0.41	0.36	0.43	0.38	0.53	0.47
Soybean Expeller	42.0	2.50	2.25	0.58	0.52	0.62	0.51	1.64	1.39	0.52	0.50	2.94	2.73	1.88	1.67	1.99	1.75
Soybean Meal (44%)	44.0	2.71	2.44	0.59	0.54	0.63	0.52	1.73	1.47	0.60	0.54	3.20	2.98	1.99	1.77	2.09	1.84
Soybean Meal (47.8%)	47.8	2.91	2.62	0.64	0.58	0.68	0.56	1.86	1.58	0.64	0.57	3.49	3.24	2.17	1.93	2.26	1.99
Soybean, full-fat	38.0	2.40	2.09	0.54	0.48	0.55	0.43	1.69	1.39	0.52	0.45	2.80	2.52	2.18	1.87	2.02	1.72
Sunflower Meal (34%)	34.0	1.17	1.02	0.74	0.68	0.55	0.44	1.22	1.00	0.45	0.39	2.75	2.56	1.37	1.22	1.65	1.43
Sunflower Meal (41%)	41.0	1.37	1.19	0.88	0.81	0.66	0.53	1.45	1.19	0.54	0.47	3.42	3.18	1.66	1.48	1.99	1.73
Triticale	12.5	0.38	0.33	0.20	0.18	0.27	0.23	0.38	0.33	0.13	0.11	0.61	0.50	0.41	0.38	0.54	0.47
Wheat (13.5%)	13.5	0.36	0.31	0.20	0.19	0.29	0.26	0.38	0.33	0.16	0.14	0.64	0.54	0.45	0.37	0.56	0.50
Wheat (10.8%)	10.8	0.31	0.27	0.17	0.15	0.25	0.22	0.31	0.27	0.14	0.12	0.52	0.44	0.36	0.29	0.46	0.41
Wheat Bran	14.8	0.60	0.43	0.22	0.17	0.30	0.22	0.48	0.35	0.24	0.19	1.00	0.82	0.46	0.36	0.67	0.52
Wheat Middlings	15.0	0.60	0.48	0.23	0.19	0.30	0.22	0.48	0.35	0.21	0.17	1.00	0.80	0.47	0.39	0.69	0.53

Amino acid digestibility is standardized ileal digestibility. Amino acid values are standardized for 88% dry matter (Source: Evonik AminoDAT® 4.0, 2010). Values provided are "typical" based on ingredient surveys. Nutrient values should be confirmed by analysis of the materials being used in order to maintain an accurate formulation matrix.

[1] For more information, see the "Feeding Rapeseed Meal or Canola Meal to Hy-Line Brown and Hy-Line Silver Brown Hens" Product Update at www.hyline.com.

Hy-Line International Welfare Goals and Principles

To promote animal well-being and produce birds of the highest quality, we adhere to the following welfare goals and principles. These goals and principles are the essential building blocks for the humane and professional care of our birds:

- **Feed and Water**
  Provide access to good quality water and nutritionally balanced diets at all times
- **Health and Veterinary Care**
  Provide science-based health programs and prompt veterinary care
- **Environment**
  Provide shelter that is designed, maintained and operated to meet the bird's needs and to facilitate daily inspection
- **Husbandry and Handling Practices**
  Provide comprehensive care and handling procedures that ensure the bird's well-being throughout its life
- **Transportation**
  Provide transportation that minimizes travel time and stress

RESOURCES AVAILABLE AT WWW.HYLINE.COM

Corporate Information | Technical Updates | Interactive Management Guides
Hy-Line International Lighting Program | Hy-Line EggCel | Body Weight Uniformity Calculator

TECHNICAL UPDATES

Diseases

An Overview of Focal Duodenal Necrosis (FDN)
MG Control in Commercial Layers
Colibacillosis in Layers: An Overview
Fowl Pox in Layers
Avian Urolithiasis (Visceral Gout)
Infectious Bursal Disease (IBD, Gumboro)
Fatty Liver Hemorrhagic Syndrome
Infectious Laryngotracheitis (ILT)

Diagnostic Samples and Breeder Flock Monitoring

Salmonella, *Mycoplasma*, and Avian Influenza Monitoring in Parent Breeder Flocks
Proper Collection and Handling of Diagnostic Samples

Management

Growing Management of Commercial Pullets
Understanding the Role of the Skeleton in Egg Production
The Science of Egg Quality
Understanding Poultry Lighting
Understanding Heat Stress in Layers
Infrared Beak Treatment
Feed Granulometry and the Importance of Feed Particle Size in Layers
Impact of Tarp Color on Poultry Lighting
SPIDES (Short Period Incubation During Egg Storage)
Fly Management: Surveillance and Control
Optimizing Egg Size in Commercial Layers

PRODUCT UPDATES

Hy-Line Brown – Selecting for Superior Egg Quality
Feeding Rapeseed Meal or Canola Meal to Hy-Line Brown and Hy-Line Silver Brown Hens

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